Los Alamos
NATIONAL LABORATORY
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Y-12
National Security Complex

UNCLASSIFIED TOUR OF THE NUCLEAR WEAPONS INSTRUCTIONAL MUSEUM

DEFENSE THREAT REDUCTION AGENCY
LAST UPDATED 7 JUNE 2012

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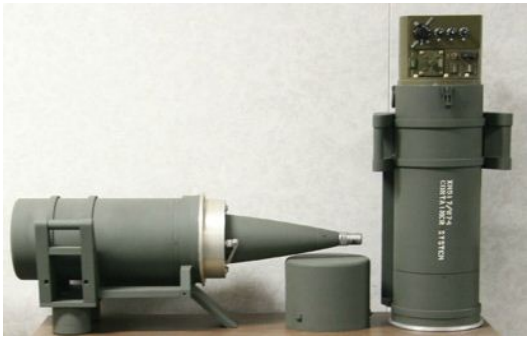
UNCLASSIFIED Area of Nuclear Weapons Instructional Museum

NUCLEAR WEAPONS THAT NEVER WERE

W74 Artillery Fired Atomic Projectile (AFAP)



Courtesy of the Electronic Declassified NWIM Tour Slideshow

General Specifications

- **Yield:** Kiloton class (Polmar and Norris 64)
- **Inventory:** cancelled (64)
- **Weapons:** 155-mm artillery projectile (64)

History of Warhead

- 1969 Army requested new 155MM shell to replace the W48 (Hansen 6:520)
- Development of W74 began at Los Alamos, March 1970 (520)
- Shell cancelled in June 1973 due to cost (each estimated at $452,000 by 1974), tactical vulnerability, and outdated technology (520)
- Shell included only nuclear fission and no “enhanced radiation” high-neutron output (520)

Sources

Hansen, Chuck. "Swords of Armageddon Volume VI: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

W82 Artillery Fired Atomic Projectile (AFAP)

General Specifications

Courtesy of the Electronic Declassified NWIM Tour Slideshow

- **Dimensions:** Length: 2 ft 10.25 in
  Diameter: 6.1 in
  Weight: 95 lbs
  (Polmar and Norris 67)
- **Yield:** Kiloton class (67)
- **Inventory:** cancelled (67)
- **Weapons:** 155 – mm artillery projectile (67)

History of Warhead

- Originally designed in both “enhanced radiation” and standard fission models (Hansen 6:525)
- Development engineering started in Livermore, September 1977 and stopped in 1982 (525)
- W82-0 was cancelled in October 1983 (525)
- Used radar airburst fuse (526)
- Carrying case was a sophisticated container with security locks (W82/XM-785) (526)
- Segmented rocket booster propellant charge allowed choice of ranges, with a maximum of 30 km (Jane’s)
- Funding was removed from FY 1991 defense budget and program was cancelled (Hansen 526)

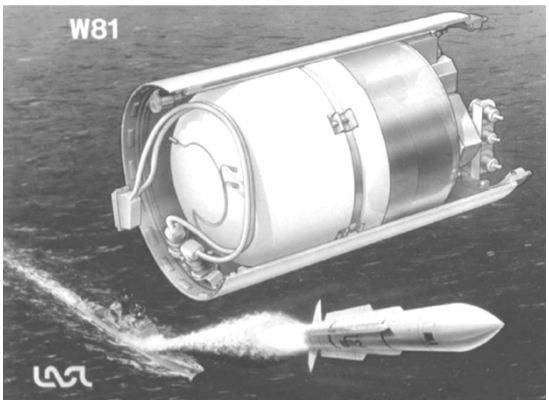
Sources

Hansen, Chuck. "Swords of Armageddon Volume VI: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

Jane’s. "155 Mm XM785 Nuclear Projectile (United States), Field Artillery." *Janes.com*. Jane's. Web. 06 June 2012. <http://articles.janes.com/articles/Janes-Ammunition-Handbook/155-mm-XM785-nuclear-projectile-United-States.html>.

W81 Standard Missile



Hansen 6:188

General Specifications

- **Yield:** Kiloton class (Polmar and Norris 67)
- **Inventory:** cancelled (67)
- **Weapons:** Standard-ER surface-to-air missile
- Planned Replacement for the ship-launched Terrier-BTN missile. (67)

History of Warhead

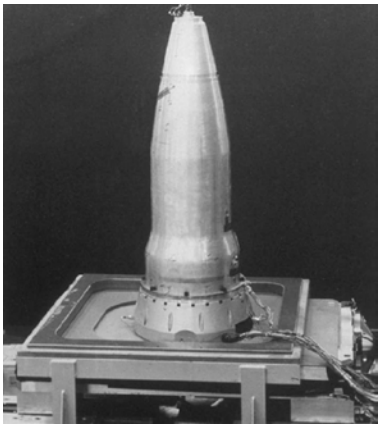
- Designed as warhead for the Navy's Standard SM-2 antiaircraft rocket (TERRIER replacement) (Hansen 6:188)
- Variant of MK/B61 primary (189)
- IOC date of 1984 later changed to 1987 (188)
- May 1978 Senate Armed Services Committee revoked funding for W81 because the superior accuracy of the AEGIS-class cruisers negated the need for the use of nuclear weapons. Instead they pushed for non-nuclear weapons to be used with this system. (FY 1979 Defense Authorization Bill) (188)
- Cancelled in 1986 when Congress deferred production of a nuclearized STANDARD missile (189)

Sources

Hansen, Chuck. "Swords of Armageddon Volume VI: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

W89 Short Range Attack Missile – II (SRAM-II)



Early Test Model (Hansen 6:127)

General Specifications

- **Dimensions:** Length: 3 ft 4.875 in
  Diameter: 1 ft 1.33 in
  Weight: 324 lbs (Polmar and Norris 70)
- **Yield:** Kiloton class (70)
- **Inventory:** cancelled (70)
- **Weapons:** Sea Lance ASW missile (cancelled)
  SRAM II air-to-surface missile (cancelled) (70)

History of Warhead

- Designed to be new thermonuclear warhead for the SRAM II air-to-surface missile (Hansen 6: 124)
- SRAM II slated for service in mid to late 1994 (124)
- Included improved safety and security features with comparable yield to existing warheads (126)
- Incorporated fire resistant pit and enhanced nuclear detonation safety (126)
- The SRAM-2 was developed for the B-1B bomber and was supposed to use a W89 warhead. Up to 36 missiles could be carried by the B-1B (Encyclopedia Astronautica “SRAM-2”)
- Cancelled in late September 1991 (Hansen 6:128)

Sources

Hansen, Chuck. "Swords of Armageddon Volume VI: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

"SRAM-2." *Encyclopedia Astronautica*. Web. 06 June 2012. <http://www.astronautix.com/lvs/sram2.htm>.

W91 Short Range Attack Missile – Tactical (SRAM-T)

General Specifications

- **Dimensions:** Weight: 310 lbs
  (Polmar and Norris 70)
- **Yield:** Kiloton class (70)
- **Inventory:** cancelled (70)
- **Weapons:** aircraft bomb (70)
  SRAM-T surface-to-air missile

Courtesy of the Electronic Declassified NWIM Tour Slideshow

History of Warhead

W91 Short Range Attack Missile- Tactical (Air Force SRAM-T)

- Designed by Los Alamos for the SRAM-T air to surface missile, which was a variant of Boeing SRAM II. (Hansen 6:128)
- Armed with digital commands, rather than pulses of energy (less chance for accidental detonation) (129)
- The SRAM-T was supposed to be used on the F-15E, but the entire program was cancelled at the end of the Cold War due to political reasons after the collapse of the Soviet Union (Encyclopedia Astronautica "SRAM-2")
- Program cancelled in late September 1991 (Hansen 6:129)

Sources

Hansen, Chuck. "Swords of Armageddon Volume VI: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

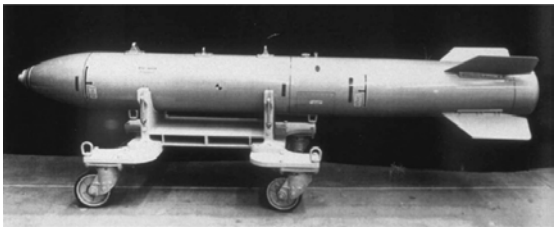
Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

"SRAM-2." *Encyclopedia Astronautica*. Web. 06 June 2012. <http://www.astronautix.com/lvs/sram2.htm>.

B90 Nuclear Strike Depth Bomb

General Specifications

- **Dimensions:** Length: 9 ft 10 in
  Diameter: 1 ft 1.33 in
  Weight: 780 lbs (Polmar and Norris 70)
- **Yield:** Kiloton class (70)
- **Inventory:** cancelled (70)
- **Weapons:** strike/ depth bomb (70)



Hansen 5:498

History of Warhead

- Los Alamos-designed replacement for the MK57 Navy tactical nuclear bomb (Hansen 5:497)
- Multipurpose thermonuclear bomb designed for use against submarines or surface targets (497)
- Incorporated safety features, use-control, improved operational flexibility, and improved effectiveness (IHE, fire resistant pit, and enhanced nuclear detonation safety) (497)
- Nose section tipped with kinetic energy absorbing rings (like the B83) and was capable of absorbing shocks with about 70% of length of previous nose designs (498)
- Intended for low-altitude, high-speed delivery (498)
- Capability to be fused for retarded or free-fall surface, air burst, or underwater detonation (with hydrostatic fuse) (498)
- First thermonuclear depth bomb ever developed even though it was cancelled (Norris 47)
- Cancelled in 1992 (497)

Sources

Hansen, Chuck. "Swords of Armageddon Volume V: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

Norris, Robert S., and William M. Arkin, eds. "Lulu's Grandchild Due in 1993." *Bulletin of the Atomic Scientists* 45.8 (1989): 47. Web.

W61 Nuclear Earth Penetrator Warhead (EPW)

General Specifications

- None available

Courtesy of the Electronic Declassified NWIM Tour Slideshow

History of Warhead

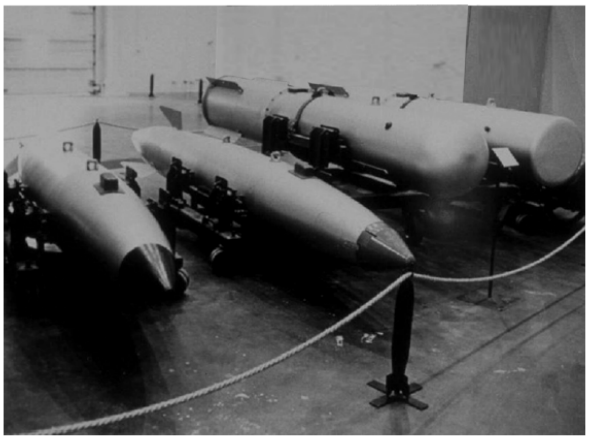
- Derivative of the B61-7 lay down bomb (Hansen 6:342)
- Earth Penetrating Warhead (EPW) (342)
- Development began July 1990 and production engineering started by May 1991 (342)
- Phase 3 produced a conversion kit that included a high-strength steel case to house carry-over components from the B61-7 in addition to new interface components (342)
- Estimated IOC date of 1994 (343)
- Would have eventually replaced the MK53 aerial bombs (343)
- Used Insensitive High Explosives (IHE) and enhanced electrical isolation of firing circuits (343)
- Display shows two W61's: one powder coated Dark Gray and one Polished Steel

Sources

Hansen, Chuck. "Swords of Armageddon Volume VI: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

US ACTIVE STOCKPILE

MK28



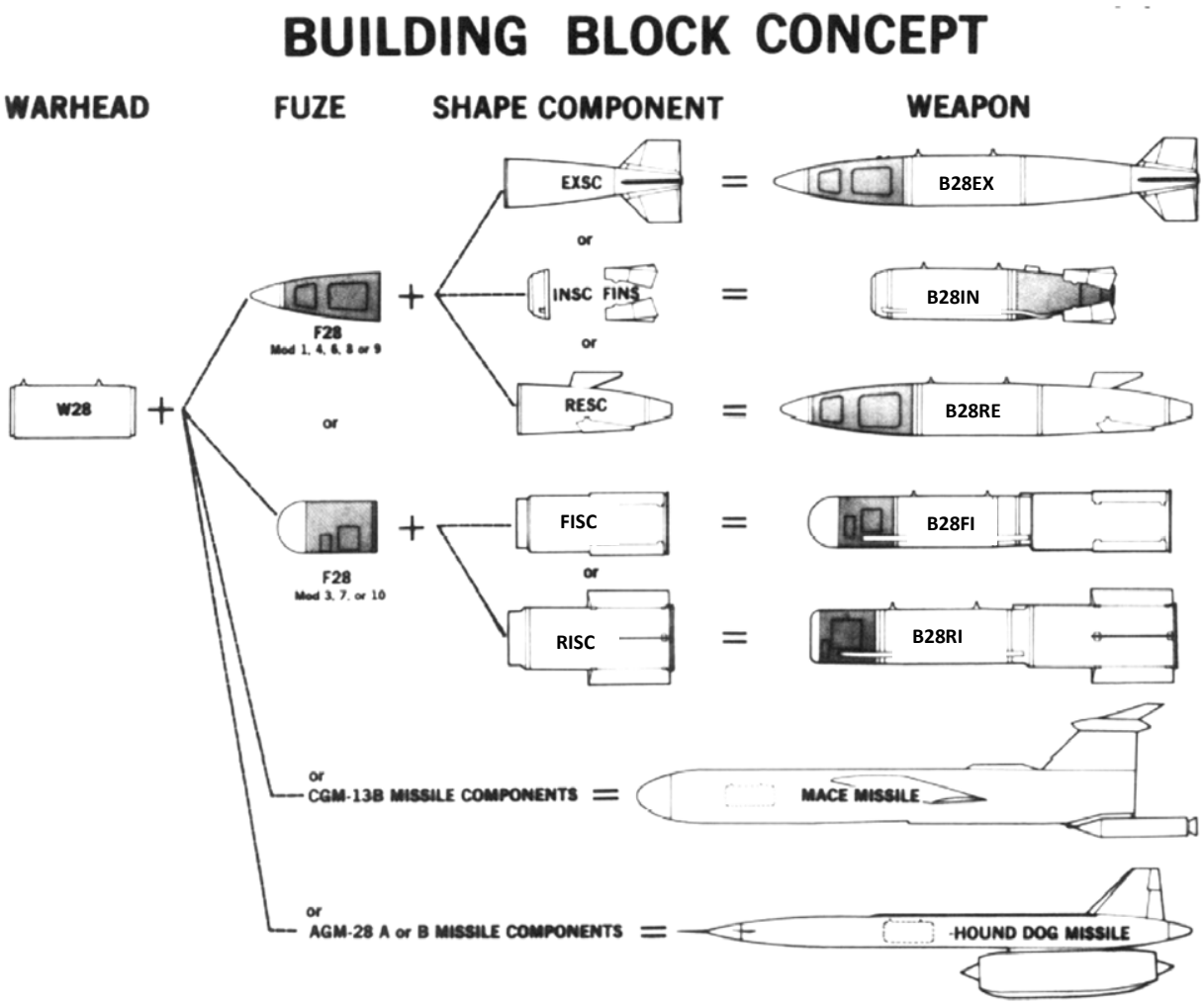
Hansen 5:436

General Specifications

- **Yield:** Y1 Megaton
  Y2 Megaton
  Y3 Kiloton
  Y4 Kiloton
  Y5 Kiloton
  (Polmar and Norris 49)
- **Inventory:** Sept 1958-1991 (49)

History of Warhead

- One of the longest-serving, most common thermonuclear weapons (Hansen 5:434)
- Approximately 4,500 bombs produced between August 1958 and May 1966 (total only surpassed by W-68 Poseidon SLBM) (434)
- Standard arm of USAF SAC and TAC bombers and fighter-bombers (434)
- As late as 1982, still deployed in two tactical bombs and a strategic lay down bomb (434)
- MK28 aerial gravity bomb produced using “Building Block Concept” in five variants: (436)
  - IN: Free-fall internal carriage
  - EX: Free-fall external carriage
  - RE: Parachute-retarded external carriage
  - RI: Parachute-retarded internal carriage
  - FI: Fully-fused, parachute-retarded internal carriage
- The five different variants allowed for the bomb to be tailored for any kind of aircraft or attack mode (Gibson 97)
- All mods were retired by 1991 (Hansen 5:456)



Hansen V-435

Sources

Gibson, James N. *Nuclear Weapons of the United States: An Illustrated History*. Atglen, PA: Schiffer Pub., 1996. Print.

Hansen, Chuck. "Swords of Armageddon Volume V: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

W28 MACE and W28 HOUND DOG

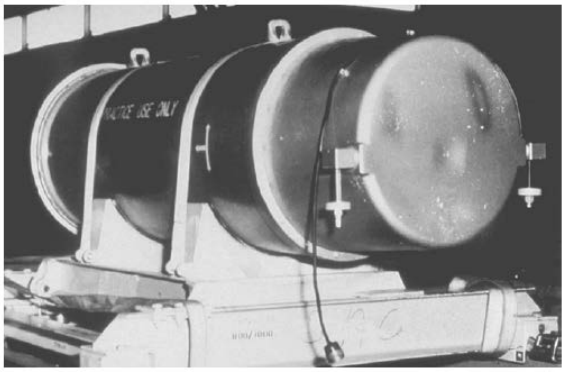


Figure 18 *W-28 warhead as used in the HOUND DOG*

Hansen 6:83

General Specifications of Warhead

- **Dimensions:** Length: 5 ft
  Diameter: 1 ft 8 in
  Weight: 1,500 – 1,725 lbs
  (Polmar and Norris 49)
- **Yield:** Kiloton or megaton class (49)
- **Inventory:** Hound Dog: 1960 – 1975
  Mace: Aug 1959 – 1969 (49)
- **Weapons:** Hound Dog surface-to-air missile
  Mace surface-to-air missile (49)
- The missile warhead affiliate of the B28 bomb (49)

History of Warhead

- Mod 0 warhead entered development engineering in August 1954 and production engineering in January 1957 (Hansen 6: 188)
- On January 18, 1956 production of a W28 for the MACE missile (improved version of the MATADOR cruise missile) was authorized (240)
  - Weight: 1,427 lbs
  - Diameter: 20”
- W28 Mod 0 warhead released for use in MACE missile June 1959 (240)
- Beginning in 1960, W28/MACE adaption kits and warheads were produced (240)
- All were retired by 1970 (240)

History of the Hound Dog Missile

- Inducted in 1959 (Gibson 106)
- Extended standoff range to over 500 miles and greatly increased accuracy (106)
- Could be fired from B-52’s to suppress enemy air defenses while the B-52’s continued to the target (106)
- Hound Dogs eventually replaced by SRAMs (106)

White Sands

White Sands

Sources

Gibson, James N. *Nuclear Weapons of the United States: An Illustrated History*. Atglen, PA: Schiffer Pub., 1996. Print.

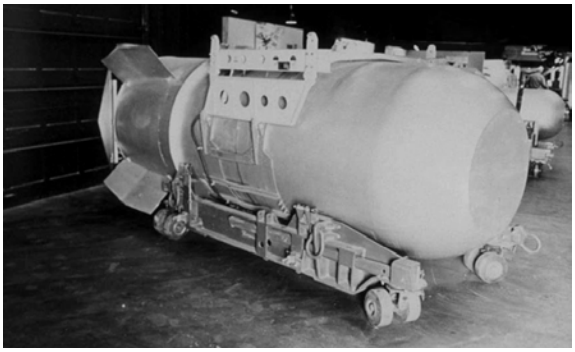
Hansen, Chuck. "Swords of Armageddon Volume VI: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

Hound Dog. Photograph. White Sands Missile Range Museum, White Sands Missile Range Museum, NM. *White Sands Missile Range Museum*. White Sands Missile Range Historical Foundation. Web. 6 June 2012. <http://www.wsmr-history.org/HoundDog.htm>.

Matador-Mace. Photograph. White Sands Missile Range Museum, White Sands Missile Range Museum, NM. *White Sands Missile Range Museum*. White Sands Missile Range Historical Foundation. Web. 6 June 2012. <http://www.wsmr-history.org/MatadorMace.htm>.

Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

B53 (MK53)



Hansen 5:431

General Specifications

- **Dimensions:** Length: 12 ft 4.8 in
  Diameter: 4 ft 2 in
  Weight: 8,800 lbs (Gibson 101)
- **Yield:** Megaton class (101)
- **Inventory:** 1962 – approx 2004 (Polmar and Norris 58)
- **Carriers:** Air Force: B-2, B-52, B-58, B-47, XB-70, and Titan II (101)
- **Weapons:** aircraft bomb (58)
- One of the largest nuclear bombs deployed by the United States in mass (58)

History of Bomb

- In late December, 1959, AEC asked LASL and Sandia to develop a full fusing option (FUFO) bomb which could be fused for either airburst, contact burst, or "lay down" delayed surface burst (Hansen 5:425)
- MK53 warhead for the BLU-2/B pod for the B-58 Hustler aircraft was designated BA53-Y1 (428)
- Retirement of early MK53 mods began in July, 1967 (429)
- Some MK53 Mod 1s remained in service to mid-1987, when they were slated for retirement and replacement by much lower yield B 83 bombs (429)
- August 5, 1987 DOD curtailed retirement, bringing the bombs back into active inventory (429)
- Bomb reactivated to retain a high-yield weapon to use against deeply-buried targets (429)
- Eventually retired and replaced by much lower yield B61 Mod 11 bombs (430)
- B53 has four fusing options: "lay down" delayed surface burst, free-fall airburst, parachute-retarded airburst, and contact (surface) burst (430)
- B-53 was a lay down bunker buster that had five parachutes that allowed the bomb to land softly on the ground, then detonate to send shockwaves through the ground to collapse deeply buried shelters. The yield was so high on this bomb because it was meant to destroy very deeply buried and reinforced shelters (Washington Post)
- One of the largest nuclear devices in the U.S. stockpile was the B53 bomb until April 1997 when it was replaced by the B61-11 (Schwartz 45)
- In 2011, at the U.S. National Nuclear Security Administration's Pantex Plant near Amarillo, Texas, the high explosives were removed from the last of the 50 B53 bombs held in reserve after the weapon was retired in 1997 (Vergano)

Sources

Gibson, James N. Nuclear Weapons of the United States: An Illustrated History. Atglen, PA: Schiffer Pub., 1996. Print.

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Schwartz, Stephen I. Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons since 1940. Washington, D.C.: Brookings Institution, 1998. Print.

Washington Post. "The Story of the B-53 'bunker Buster' Offers a Lesson in Managing Nuclear Weapons." *Washington Post*. Washington Post, 19 Oct. 2010. Web. 6 June 2012. <http://www.washingtonpost.com/wp-dyn/content/article/2010/10/18/AR2010101805915.html>.

Vergano, Dan. "U.S.-made 'monster' Nuclear Warhead B53 Dismantled." *USA Today*. Gannett, 26 Oct. 2011. Web. 07 June 2012. <http://www.usatoday.com/news/nation/story/2011-10-25/nuke-bomb-disassembly/50901152/1>.

B-58 Hustler

B-58 in Flight, April 1961

- The B-58 Hustler was deployed March 1960 (Lake 377)
- It was a delta wing bomber that could achieve speeds in excess of Mach 2 (377)
- It used bonded honeycomb paneling to help reduce excessively high temperatures (377)
- It cost the same as three B-52Gs, and had a horrible accident rate, with 18 crashes in its service life.
- The Air Force retired the last Hustler in 1970 (377)
- It was able to deploy the B53 nuclear bomb, which was one of the largest bombs ever deployed by U.S. forces (377)

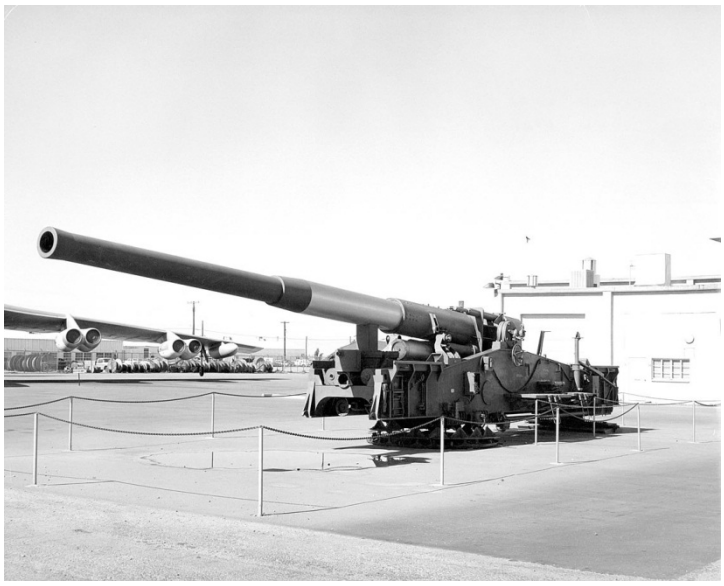
Sources

Lake, Jon. *The Great Book of Bombers: The World's Most Important Bombers from World War I to the Present Day*. London: Salamander, 2002. Print.

B-58 in Flight, April 1961. 1961. Photograph. *The Portal to Texas History*. University of North Texas Libraries. Web. 6 June 2012. <http://texashistory.unt.edu/ark:/67531/metapth40495/m1/1/?q=b-58>.

Korean War and the Nuclear Battlefield

- The Korean War started on 25 June 1950
- The concept of warfare changed dramatically after the United States used nuclear weapons against Japan to end World War II
- Before the nuclear taboo of present times, the U.S. Army viewed nuclear weapons as tactical weapons and prepared the for the possibility of a nuclear battlefield (Schwartz 37)
- The Atomic Cannon, or "Atomic Annie" was developed in 1952 to meet this need (Polmar and Norris 239)
- It could fire a Mk 9 warhead, 280 mm shell in only 15 minutes (239)
- These cannons were assigned to Army units in Okinawa and South Korea (239)
- It remained in Army service until 1963 (239)
- The following displays demonstrate the Army's nuclear artillery.



Sources

280 Mm AFAP Cannon. Photograph. *Los Alamos National Laboratory*. Web. 7 June 2012. <http://www.lanl.gov/history/gallery.php?story_id=18&page_num=1&row_num=0&photo_id=181>.

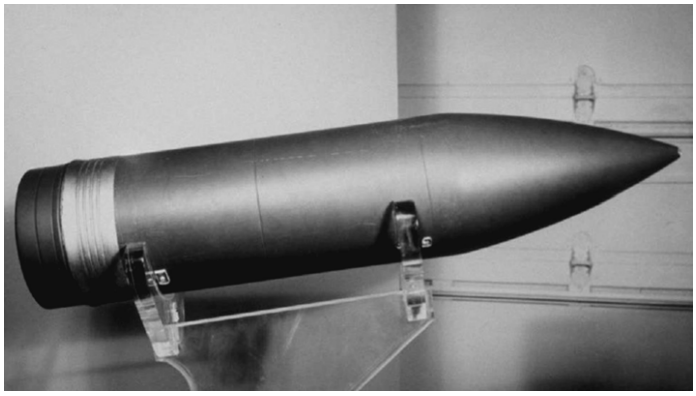
Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

Schwartz, Stephen I. "Excerpts from Atomic Audit." *Bulletin of the Atomic Scientists* September/October 54.5 (1998). *Google Books*. Web. 7 June 2012. <www.books.google.com>.

MK33 8 inch Howitzer Projectile

General Specifications

- **Dimensions:** Length: 3 ft 1 in
  Diameter: 8 in
  Weight: 243 lbs
  (Polmar and Norris 50)
- **Yield:** Kiloton class (50)
- **Inventory:** 1957 – 1991 (50)
- **Weapons:** 8- inch artillery projectile (50)



Hansen 6:505

History of Bomb

- The Army's campaign for an 8”atomic shell began in April 1952, even before the first test of a 280MM shell, because it would provide the Army and Marines with a formidable, small and maneuverable atomic attack capability (Hansen 6:501)
- In March 1953, the JCS asked the AEC to develop an 8” atomic shell and manufacturing began in January 1957 and lasted until January 1965 (502 and 504)
- Shell had a range of about six miles (505)
- The MK33 was the warhead for the M-422 and M-422C shells. The projectile was a gun assembly type 8” nuclear shell which had air-burst capability (502)
- Nuclear components had to be inserted in the field. Nuclear safety was achieved by four dashpot detents, any two of which could mechanically prevent the target rings from assembling over the projectile until after the launching howitzer was fired, and by creep stops which prevented premature assembly along the trajectory until the ignition system was activated (502)
- Retired in late 1983, although the last MK33 was retired in September 1992 (504 and 506)
- The MK33/M-422 shells were to be replaced in the national nuclear weapons stockpile by new W79/XM-753 rounds, which began deployment in 1981 (506)

Sources

Hansen, Chuck. "Swords of Armageddon Volume VI: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

W48 155 MM Howitzer Projectile

Courtesy of the Electronic Declassified NWIM Tour Slideshow

General Specifications

- **Dimensions:** Length: 2 ft 10 in
  Diameter: 6.1 in
  Weight: 128 lbs
  (Polmar and Norris 56)
- **Yield:** Kiloton class (56)
- **Inventory:** 1963 – 1991 (56)
- **Weapons:** 155-mm inch artillery projectile (56)
- This weapon was deployed with the U.S. Army and Marine Corps. (56)

History of Warhead

- MK48 Artillery Fired Atomic Projectiles (AFAPs) were manufactured October 1963-March 1968 (Hansen 6:511)
- Retirement of Mod 0s began in January 1965 and ended in 1969 (511)
- Could be fired from M-109 and M-198 155MM howitzers. (511)
- Fired by a variable-time (VT) mechanical fuse (511)
- Shell used an enhanced security system (512)
- Could be fired to a range of about four miles (512)

Sources

Hansen, Chuck. "Swords of Armageddon Volume VI: U.S. Nuclear Weapons Histories." Chukelea Publications, 1995. Web. 01 June 2012. <http://uscoldwar.com/>.

Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

W79 8 inch Howitzer Projectile

Hansen 6:524

General Specifications

- **Dimensions:** Length: 3 ft 8 in
  Diameter: 8 in
  Weight: 200 lbs
  (Polmar and Norris 66)
- **Yield:** Kiloton class (66)
- **Inventory:** Nov 1981 – 1991 (66)
- **Weapons:** 8- inch artillery projectile (66)

History of Warhead

- Replacement for the W33 AFAP (Hansen 6:521)
- Included an “enhanced radiation” option to generate lethal tank-busting neutrons to counter Soviet armored fighting vehicles equipped with neutron countermeasures (lead, cadmium, and boron hydride shielding) (521)
- Development engineering started at Livermore in January 1975 (521)
- By 1976, the Army was developing a warhead for an 8-inch atomic artillery shell that would be the first U.S. weapon specially designed to reduce collateral damage from blast and radioactivity
- First production unit appeared in July 1981 (522)
- Quantity production of the W79-1 spanned from September 1981 to the summer of 1984 (522)
- Production of the W79-0 began in 1984 and ended in August 1986 (522)
- The last W79 was retired in September 1992 as part of the vast draw-down of U.S. nuclear weaponry (522)
- 27 September 1991 President George H. W. Bush ordered the retirement and destruction of all AFAP, as well as taking many missile systems off alert and destroying hundreds of B-52s as a sign of the end of the Cold War and an attempt at reducing nuclear arms around the world (Grier)

Sources

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Polmar, Norman, and Robert S. Norris. *The U.S. Nuclear Arsenal: A History of Weapons and Delivery Systems since 1945*. Annapolis, MD: Naval Institute, 2009. Print.

W85 Pershing II

Hansen 6:353

General Specifications

- **Dimensions:** Length: 3 ft 11.5 in
  Diameter: 1 ft 0.125 in
  Weight: 880 lbs
  (Polmar and Norris 68)
- **Yield:** Kiloton class (68)
- **Inventory:** 1983 – 1991 (68)
- **Weapons:** Pershing II battlefield missile (68)
- After the INF Treaty banned the Pershing II, the warheads were converted into B61 Mod 10 bombs (68)

History of Warhead

- Los Alamos-designed air/surface burst warhead for the Army's PERSHING II missile (Hansen 6:352)
- Used major components of the B61 Mod 3 & 4 bombs (352)
- Development engineering started in May 1979 and production engineering began in September 1980 (352)
- First production units completed by February 1983 and total production spanned from May 1983—July 1986 (352)
- Replaced PERSHING IA/W50 weapon systems (352)
- Numerous W85s recycled into B 61-10 gravity bombs (352)
- Could be fused for air or surface burst (353)
- All W85s were removed from the PERSHING II after the Intermediate Nuclear Forces Treaty ratified in 1988 (352)
- Retirement began in 1988 and was completed by March 1991 (352)

Pershing II Facts

- The Pershing II guidance system began development in 1974 (Martin)
- 1977 saw the first successful test firing (Martin)
- NATO asked the US to deploy intermediate range missiles as a response to the SS-20 (Martin)
- By 1985 3 battalions of the 56th Field Artillery Brigade, equipped with the Pershing II, were operational in theater. Eventually another battalion was added, and they were all reorganized into an artillery regiment (Martin)
- The buildup of the Pershing II missiles caused protests in the United States, but once they were deployed and the highly accurate and rapidly deployable systems were publicized, the Pershing II was one of the deciding factors in bringing the Soviet Union to the bargaining table for the INF Treaty (Martin)
- After the INF Treaty was signed, all the Pershing II missiles were retired and destroyed by May 1991 (Martin)

Sources

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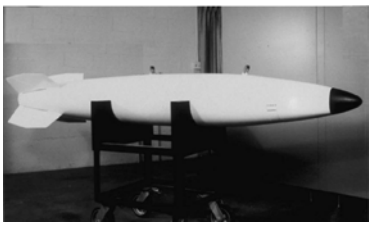
MK57



Hansen 5:465

General Specifications

- **Dimensions:** Length: 9 ft 9.5 in
  Diameter: 1 ft 2.75 in
  Weight: 510 lbs
  (Gibson 102)
- **Yield:** Kiloton class (102)
- **Carriers:** Navy: A-4, A-6, A-7, F/A-18, P-3, and SH-3 (102)
  - Only Air Force F4 were allowed to carry nuclear weapons (Polmar and Norris 59)
  - Navy and Marine Corps variants of aircraft were not nuclear armed (59)
  - Only nuclear weapon ever to be carried by unmanned aircraft QH-50C-DASH (59)
- **Inventory:** Jan 1963 - 1992 (60)
- **Weapons:** aircraft bomb (60)
- Lightweight, multipurpose, air-launched nuclear bomb designed for special tactical strikes and ASW operations; it was used by the U.S. Air Force, Navy, and Marine Corps (59)

History of Bomb

- In late 1957, the Assistant Secretary of Defense requested that the AEC and Navy cooperate in a feasibility study of a lightweight, air-dropped nuclear depth charge (Hansen 5:461)
- On March 21, 1958, the Air Forces asked the DMA to provide a low-yield nuclear bomb for "limited" nuclear warfare for use against tactical targets and for delivery on water, soil, concrete, or asphalt (461)
- Could be delivered by helicopter or from fixed-wing aircraft as a depth bomb, free-fall airburst weapon, or as a retarded "lay down" bomb (461-2)
- Smallest free-fall bomb ever deployed by the United States (Gibson 102)
- Mod 0 was design-released in December 1961 and MK57 production spanned between January, 1963 and May, 1967 (Hansen 6:462)
- Consisted of a B57-1 or B57-2 basic assembly with a N57-0,-1, or -2 nose section.
  - The N57-1 nose section contained dual-channel fusing radars and antennas and power supplies. It was developed primarily for airburst delivery but could also be used for "lay down" or depth bomb delivery. There were two water entry flooding ports used for depth bomb delivery (463)
  - The other two nose sections, N57-0 and N57-2, could be used only for "lay down" and depth bomb deliveries. The N57-2 nose section had better "lay down" characteristics and both noses had water entry flooding ports for depth bomb delivery. These controls allowed four fusing options: free-fall or parachute-retarded airburst, retarded "lay down" (delayed surface burst), and retarded underwater depth bomb (463)
- Retirement of early mods started in June, 1975. By April 1992, the MK57 Mod 1s had all been retired; the last MK57 Mod 2 was retired by June 1993 (464)

Sources

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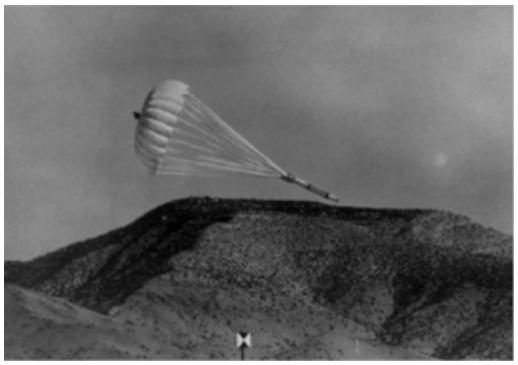
B61



Hansen 5:477

General Specifications

- **Dimensions:** Length: 11 ft 9.5 in
  Diameter: 1 ft 1.3 in
  Weight: 710 lbs
  (Gibson 102)
- **Yield:** Kiloton class (102)
- **Carriers:** Air Force: B-52, B-1B, FB-111, F-100, F-105 (internally), F-4, F-111, F-16, and F- 15E
  Navy/ Marines: A-4, A-6, A-7, AV-8B, and F/A-18 (102)
- **Inventory:** 1968 – current (Polmar and Norris 61)
- **Weapons:** aircraft bomb (61)

History of Bomb

- In the summer of 1960, the Air Force became interested in drogue-retarded atomic weapons which could be dropped at very high speeds from altitudes as low as 300 feet (Hansen 5:467)
- Built as Mods 0, 1, 2, 3, 4, 5, 7, 10 and 11 starting in 1966. The B61-0, 2 and 5 are all retired. Mod 1 was converted to the Mod 7 (471)
- Available in both tactical and strategic versions. All mods except for the 7 and 11are tactical weapons. (474)
- Mod 11 became operational at the end of 1996 and is an earth-penetrating weapon (replacing retired MK 53 bombs) with a new strengthened and streamlined casing. The Mod 11s are modified Mod 7s. The Mod 11 can penetrate 15 to 25 feet into the ground before detonating (481-2)
- The Circular Error Probability (CEP) for "lay down" delivery is on the order of approximately 200 yards (478)
- Can be fused for free-fall or retarded airburst, "lay down" delayed surface burst and free-fall contact burst (482)

Current Events

- The Pentagon recently launched a $1.2 billion competition to design and create a tailkit for the next reincarnation of the B61 gravity bomb (Sherman)
- The tailkit acquisition is part of a policy goal the Obama Administration set forth in the 2010 Nuclear Posture Review to “retain the capability to forward-deploy U.S. nuclear weapons on tactical fighter-bombers and heavy bombers” (Sherman)
- The B-61 is needed to arm the new bomber platform (Sherman)
- Production engineering slated to begin in FY 2016 and initial production would follow in FY 2019 (Sherman)

Sources

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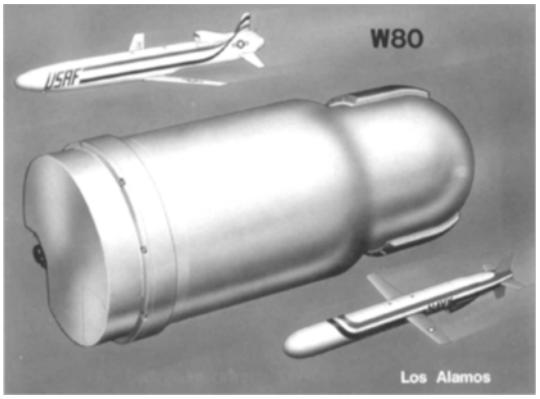
W80 ALCM / ACM / SLCM



Hansen 6:120

General Specifications

- **Dimensions:** Length: 2 ft 7.34 in
  Diameter: 11.75 in
  Weight: 290 lbs
  (Polmar and Norris 66)
- **Yield:** Kiloton class (66)
- **Inventory:** 1982 – current (66)
- **Weapons:** Mod 0 Tomahawk land-attack missile.
  Mod 1 ALCM/ ACM air-to-surface missiles
- This warhead is a modification of the B61 bomb (66)

History of Warhead

- Produced as a warhead for the Air Force's Air-Launched Cruise Missile (ALCM) and "stealthy" Advanced Air-Launched Cruise Missile (ACM) (Hansen 6:119)
- Development engineering for both W80 mods started at Los Alamos in June 1976. Quantity production of the W80 started in February 1982 and was completed by the end of FY 1990. For a while, the W80 was also considered as a replacement for the W69 SRAM warhead (119, 122-3)
- Production engineering of the W80-1 (ACLM) began in January 1979 and first production units rolled out in January 1981 (119)
- The W80-0 was carried by the Navy's TOMAHAWK Sea-Launched Cruise Missile (SLCM) (119)
- Production engineering of the W80-0 for the SLCM started in March 1982 and quantity production began in March 1984 and continued until the summer of 1990 (349)

Sources

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W84 GLCM

Hansen 6:351

General Specifications

- **Dimensions:** Length: 2 ft 8 in
  Diameter: 1 ft 1 in
  Weight: 388 lbs
  (Polmar and Norris 68)
- **Yield:** Kiloton class (68)
- **Inventory:** 1983 – 1991 (68)
- **Weapons:** Gryphon surface-to-surface missile (68)

History of Warhead

- Warhead for the Air Force's Ground-Launched Cruise Missile (GLCM) (Hansen 6:350)
- Development engineering began at Livermore in September 1978 and production engineering started in December 1980. First production units appeared in June 1983 (350)
- Could be fused for air or surface burst, and final arming did not occur until the GLCM's terrain-following radar indicated that the missile was in the target area (352)
- Included improved security and safety features (352)
- Specifications are comparable to those of the W80, although the W84 is considerably heavier than the W80 (352)
- After the Intermediate Nuclear Forces (INF) Treaty in 1988, the W84/GLCM weapon system was destroyed and W84s were placed in retirement pending dismantlement (350)

Sources

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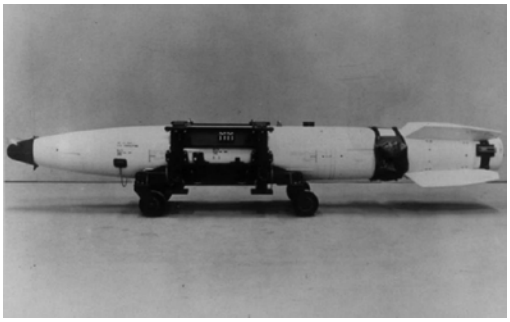
MK43


Hansen 5:410

General Specifications

- **Dimensions:** Length: 12 ft 6 in
  Diameter: 1 ft 6 in
  Weight: 2100 lbs (Gibson 100)
- **Yield:** Megaton class (100)
- **Carriers:** Air Force: F-100, F-101, F-104, F-105, F-4, A-7, F-111, F-16, B-47, B-52, B-58, B-66, and FB-111. Navy: FJ-4B, A-1, A-3, A-4, A-5, A-6, A-7, and F-4 (100)
- **Inventory:** Apr 1961 – 1991 (Polmar and Norris 54)
- **Weapons:** aircraft bomb (54)
- The B43 was produced with two different nose configurations. The Mod 0 was configured with a steel spike to penetrate hard targets and hold the bomb in place for a delayed surface burst. The Mod 1 nose had a radar fusing device that set air bursts (54)

History of Bomb

- Designed as a small, lightweight weapon capable of low level supersonic delivery to arm Mach aircraft (Hansen 5:402)
- Production engineering began February 1959 and accepted for production in March 1960 (405)
- Manufactured with two different, interchangeable noses
  - Mod-0: steel spike nose to penetrate hard targets, holding the bomb in place upon impact for a delayed surface (“lay down”) burst (407)
  - Mod-1: contained a fusing radar set for airbursts (407)
  - N43-0: one fusing option, parachute-retarded “lay down” – no radars (407)
  - N43-1: 4 fusing options and contained a fusing radar set, the forward fuse section, and interconnecting circuitry (408)
- As a laydown weapon, the MK43 was parachute-retarded and fired by a timer (408)
- As a free-fall weapon, the MK43 was fired by a fusing radar with a timer backup (408)
- As a parachute-retarded airburst, the MK 43 was detonated by a fusing radar (408)
- Could be carried externally or internally (409)
- All variants of the MK 43 were retired by May 1, 1991 and replaced by B61-3/4 and B83 bombs (412)

Sources

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W69 Short Range Attack Missile (SRAM)


Agm-69a-2

General Specifications

- **Dimensions:** Length: 2 ft 6 in
  Diameter: 1 ft 3 in
  Weight: 275 lbs
  (Polmar and Norris 63)
- **Yield:** Kiloton class (63)
- **Inventory:** 1972 – 1990 (63)
- **Weapons:** SRAM-A air-to-surface missile (63)

History of Warhead

- Warhead for the Air Force's air-to-ground Short-Range Attack Missile (SRAM) (Hansen 6:114)
- Nicknamed the “Rubber Rocket,” this missile is almost radar invisible because it was covered in 2 cm of soft rubber that absorbed radar energy (Cadirci 21) PLEASE TOUCH THE DISPLAY!
- When deployed from the B-52, SRAMs greatly increased survivability of the aircraft by neutralizing radar and surface-to-air missile sites located on the B-52’s route to the target (Gibson 114)
- Soft to medium-hard military value targets included: airfields, supply depots, urban industrial areas, command and control centers, surface-to-air missile sites including radar antennas, missile launchers, electronic equipment, and missile storage/maintenance areas; and ground radar facilities such as Ground-Controlled Intercept, early warning, and air traffic control radars (Hansen 6:114-5)
- W69 payload section on the SRAM contained a 275 lb. warhead, an impact fuse, and provisions for radar-homing equipment (117)
- Air and ground burst fusing controlled by an inertial guidance unit and contact fusing was provided by a base-detonating piezoelectric device which served as a backup or "salvage" fuse to the airburst fusing system (117)
- Armed in two phases, including initial arming after the missile had flown a predetermined distance (117)
- Retired starting in FY 1992 (October 1991 - September 1992) and completed within FY 1994 (October 1993 - September 1994) (117)

Sources

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B83

Hansen 6:188

General Specifications

- **Dimensions:** Length:12 ft 1 in
  Diameter: 1 ft 6 in
  Weight: 2,465 lbs
  (Polmar and Norris 68)
- **Yield:** Megaton class (105)
- **Carriers:** Air Force: B-1B, B-52, FB-111, F-111, F-4, F-16, F-15, and A-7
  Navy: A-4, A-6, A-7, AV-8B, and F/A-18 (Gibson 105)
- **Inventory:** 1984 – current (Polmar and Norris 68)
- **Weapons:** aircraft bomb (68)
- Designed to be effective against hardened targets. (67)

History of Warhead

- Livermore thermonuclear bomb (Hansen 5:489)
- Latest strategic gravity bomb to enter the U.S. nuclear weapons stockpile (489)
- Started out as a lower-cost alternative to the canceled B77 and incorporated most of the major features of the B77 (489)
- Entered production engineering in September, 1980 and first production units were completed by June, 1983 (489)
- Uses a special stainless steel shock mitigation nose cone, a series of concentric frangible rings (490)
- Can be fused for either free-fall or parachute-retarded airburst, free-fall contact (surface) burst, or "lay down" retarded and delayed surface burst, its primary delivery mode (491)
- Delivery altitudes range from 150 to 50,000 feet, at speeds up to Mach 2. The highest "lay down" delivery speed is Mach 1.2 (491)
- Weapon includes a 48-foot diameter Kevlar-and-nylon ribbon single-stage parachute deployed by three small 4'-diameter pilot chutes. The parachute-retarded B83 impacts at about 53 MPH (491)

Sources

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US MISSILE HALLWAY

W39 Redstone Missile (MRBM)

Hansen 6:271

General Specifications of Warhead

- **Dimensions:** Length: 8 ft 10 in
  Diameter: 2 ft 11 in
  Weight: 6230 - 6400 lbs
  (Polmar and Norris 52)
- **Yield:** Megaton class (52)
- **Inventory:** 1958 – 1965 (52)

History of Warhead

- Warhead section composed of an alloy steel skin and circular ring frames (Hansen 6:273)

General Specifications of Missile

- **Operational**: 18 June 1958—June 1964 (Polmar and Norris 236)
- **Dimensions:** Length: 69 ft 4 in
  Diameter: 5 ft 10in
  Weight: 61,346 (236)
- **Range**: approximately 200 miles (236)
- **Liquid, single stage** (Lennox 551)
- **CEP of approximately 1000 ft** (Polmar and Norris 235)

Redstone Missile (*White Sands*)

History of Missile

- 1st Medium Range Ballistic Missile every deployed by the U.S. Army (Gibson 164)
- 1st American land-based missile able to strike Soviet territory from forward bases (Polmar and Norris 235)
- Maximum altitude of the missile was 318,000 feet, with a 56 nautical mile range at that altitude (Hansen 6:273)
- At one point the missile was named Major, to fit in with the Private, Corporal, and Sergeant name series (Polmar and Norris 235)
  - The Private was the test vehicle and technological predecessor to the Corporal and Sergeant missiles. It was first launched in 1944 and was retired in 1947. (Encyclopedia Astronautica)
- Used on 31 January 1958 as the first stage to launch into orbit the Explorer 1, the West's first scientific Earth satellite (236)
- In 1961 Redstone missiles were used for the two manned suborbital Mercury flights flown by Alan Shepard and Virgil "Gus" Grissom (236)

- “A modified Redstone missile topped with a Mercury capsule called Freedom 7 launched the first American, Alan Shepard, into space.” Freedom 7 did not enter orbit, but it was the country’s first step into manned spaceflight (LePage)
- August 29 1949 detonation of the Soviet Union’s first nuclear device and the start of the Korean War on 25 June 1950 forced Congress to increase military spending and facilitate funding of the Redstone missile. (Gibson 164)

Sources

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W7 Corporal Missile (SRBM)

Hansen 6:212

General Specifications of Warhead

- **Dimensions:** Length: 9 feet
  Diameter: 30 inches
  Weight: 250 lbs
  (Hansen 6:213)
- **Yield:** Kiloton class (213)
- **Inventory:** 1953-1965 (212-3)

History of Warhead

- MK7 Mod 3 CORPORAL warhead design was released in September 1962 and production began in June 1963 (213)
- MK7 Mod 4 CORPORAL warhead design was released in July 1963, and production started the following month. Approximately 300 MK7s for the CORPORAL were manufactured between September 1953 and October 1963 (213)

General Specifications of Missile

- **Operational**: 1953—1964 (Polmar and Norris 229)
- **Dimensions**: Length: 46 ft
  Diameter: 30 in
  Weight: 11,250 lbs
- **Range**: approximately 75 miles (236)
- **Liquid Propellant**

Corporal Missile (*White Sands*)

History of Missile

- Successor to the PRIVATE and a predecessor to the SERGEANT missile (Hansen 6:208)
- The first U.S. missile to be approved as an atomic warhead carrier (208)
- The first U.S. ballistic missile unit to be deployed overseas, for reasons more psychological and political than military (212)
- First ballistic missile to enter U.S. service and was the U.S. Army's first nuclear weapon (Polmar and Norris 228)
- IOC: 1 January 1953 (229)
- 31 March 1963 the first Corporal battalion in Europe was inactivated, and by 25 June 1964 the last Corporal artillery unit was inactivated to be replaced by the Sergeant ballistic missile (229)
- All were retired by 1965 (Hansen 6:213)
- Required 7 hours to prepare for launch. A firing battalion consisted of 15 vehicles and 250 men (Polmar and Norris 228-9)
- The first U.S. guided missiles that saw service in a foreign country and used by a foreign military service (Great Britain) (229)

Sources

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W7 / W31 Honest John Missile (SRBM)

Hansen 6:242

General Specifications of Warhead

- **Dimensions:** Length: 3 ft 4 in
  Diameter: 2 ft 6 in
  Weight: 900 - 945 lbs
  (Polmar and Norris 50)
- **Yield:** Kiloton class (50)
- **Inventory:** Oct 1959 – 1984 (50)
- **Weapons:** Honest John surface-to-surface missile (50)

History of Warhead

- W7s were produced starting in October, 1955 but all were retired by 1960 (Hansen 6:220)
- The W7 was replaced by the W31, which became operational in 1959 (241)
- October 25, 1956—MLC recommended that the XW-31Y2 warhead be authorized for marriage to the Army's HONEST JOHN missile (241)
- The warhead could be fused for air or surface burst with selectable height-of-burst up to 6,500 feet (241)
- Retirement of the HONEST JOHN warheads began in July 1967 and was completed by mid-1987 (241)

General Specifications of Missile

Honest John Missile (*White Sands*)

- **Operational**: Nov 1954-1979
- **Dimensions:** Length: 27 ft 3 in
  Diameter: 30 in
  Weight: 5,820 lbs
  (Gibson 177)
- **Range:** 3 - 24 miles (Polmar and Norris 230)
- **CEP:** approximately 1000 ft (Gibson 177)
- **Solid Fuel** (Polmar and Norris 230)

History of W7 / W31 Honest John Missile

- May 1950 a program was initiated for a large-caliber, free-flight rocket capable of delivering a 1,500 lbs. atomic warhead to a range of about 8.5 miles. In August, the maximum range requirement increased to just over 11 miles (Hansen 6:215)
- 1st nuclear-tipped rocket to be deployed by the U.S. Army (Gibson 177)
- Easiest to operate of all U.S. nuclear weapons deployed in the fifties (178)
- Deployed in 1954 as a U.S. Army battlefield nuclear weapon system (Polmar and Norris 229)
- IOC: November 1954 (239)

Sources

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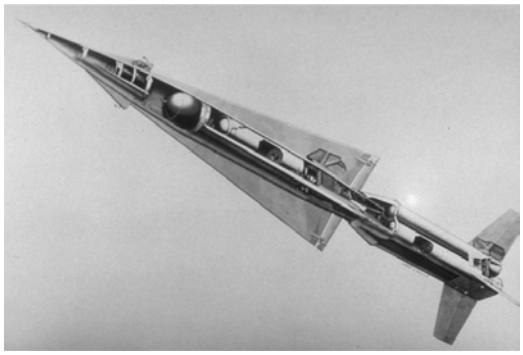
W7 / W31 Nike Hercules Missile (MRBM)



Hansen 6:137

General Specifications of Warhead

- **Dimensions:** Length: 3 ft 4 in
  Diameter: 2 ft 6 in
  Weight: 900 - 945 lbs
  (Polmar and Norris 50)
- **Yield:** Kiloton class (50)
- **Inventory:** Oct 1958 – 1984 (50)
- **Weapons:** Nike-Hercules surface-to-air missile (50)

History of Warhead

- In March 1959, Sandia proposed incorporation of handling-safety devices in W31 warheads and the W-31 Mod 2 warhead design was released in June 1962. Early production of Mod 2 warheads started in March 1963. (The MK31 Mod 1 warhead was used in an Army Atomic Demolition Munition) (Hansen 6:158)
- One of the most widely used tactical nuclear warheads (Polmar and Norris 50)
- Retirement of W31/NIKE HERCULES warheads began in July 1967 and was completed by September 1989 (Hansen 6:158)

Nike Hercules (*White Sands*)

General Specifications of Missile

- **Operational:** June 1958-1988
- **Dimensions:** Length: 41 ft 6 in
  Diameter: 2 ft 7.5 in
  Weight: 5,820 lbs
  (Polmar and Norris 212)
- **Range:** 88 miles (Gibson 193)
- **Solid Fuel** (Polmar and Norris 212)

History of Missile

- Nike missiles were named according to Greek mythology. “Nike” is the goddess of victory (Polmar and Norris 212)
- The United States established approximately 250 Nike sites to defend major population and industrial centers against Soviet Bombers (212)
- The Nike-Hercules was designed to defend the country against high-altitude bomber formations (Morgan and Berhow 64)
- Due to performance limitations of the NIKE AJAX system, and the rapid postwar advancements in bomber ceilings, speeds, and nuclear payload capabilities, the Army needed a new version of the NIKE missile carrying the 30-inch XW7 warhead and using AJAX ground radars (Hansen 6:130)

- The primary role of the second-generation NIKE system was to attack, with a single atomic warhead, formations of aircraft flying at speed up to 870 knots (1,000 MPH) at altitudes up to 60,000 feet, and at a horizontal range of 50,000 yards, and possibly up to 110,000 yards, or 62.5 miles, from the missile launch site (132)
- The HERCULES was significantly larger than the AJAX (132)
- The booster of the Nike Hercules contained four Nike-Ajax motors (Gibson 193)
- IOC: June 1958 (Polmar and Norris 212)
- The missile could be fired at targets traveling at speeds up to Mach 3 at altitudes up to 100,000 feet (Hansen 6:158)
- It was the most powerful surface-to-air missile deployed by the U.S. Army (Gibson 194)
- In yet another role, the NIKE HERCULES, like the NIKE AJAX, could also be used as a surface-to-surface missile (158)
- Deployed in Greenland, Guam, Okinawa, West Germany, Belgium, Greece, Italy, and South Korea (Polmar and Norris 212)

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W40 LaCrosse Missile (SRBM)

Hansen 6:275

General Specifications of Warhead

- **Dimensions:** Length: 31.67 in
  Diameter: 1 ft 6 in
  Weight: 350 - 380 lbs
  (Polmar and Norris 53)
- **Yield:** Kiloton class (53)
- **Inventory:** Mods 1, 2 Lacrosse 1959-1964 (53)
- **Weapons:** Lacrosse surface-to-surface missile (53)

History of Warhead

- On January 26, 1956, the Assistant Secretary of Defense requested a feasibility study of suitable atomic warheads for the Army's LACROSSE surface-to-surface tactical missile (Hansen 6:273)
- In late May, Sandia proposed using the primary stage of the MK 28 thermonuclear bomb for the LACROSSE, and the nomenclature of XW40 was later assigned to the new warhead design (274)
- The LACROSSE, originally conceived as a conventional short-range battlefield support missile with a 100 lb. shaped-charge HE warhead, had been upgraded in 1951 to carry a 500 lb. conventional warhead that increased gross missile weight by less than 35%. This permitted nuclear warheads to be fitted to the missile. Development of the XW40 warhead was recommended for this application (274)
- Production engineering of the XW-40 started in February 1958 (225)
- The MK40 was design-released by Sandia in July 1958 and production of the W40 for the LACROSSE began in June 1959 (276)
- All LACROSSE W40s were retired between October 1963 and mid-1964 (276)

General Specifications of Missile

- **Operational:** July 1972-1992 (Polmar and Norris 231)
- **Dimensions:** Length: 19 ft 2 in
  Diameter: 1 ft 8.5 in
  Weight: 2360 lbs (231)
- **Range:** approximately 19 miles (231)
- **Solid Fuel** (231)

LaCrosse Missile (White Sands)

History of Missile

- The LaCrosse Missile was the third nuclear capable missile that the U.S. Army deployed (Gibson 182)
- The U.S. Marine Corps initiated the project because of the need for a short range, highly accurate missile that could be used against caves and other protected positions (Polmar and Norris 230)
- In 1949, the Joint Chiefs shifted control of all land based guided missiles to the Army, where the LaCrosse program fell dormant (Gibson 182)
- After the start of the Korean war, the Army restarted the LaCrosse project (182)
- Development of the missile progressed slowly (182)
- The downside to this missile was its extreme complexity. It was only accurate under perfect conditions with expert operators and was a maintenance nightmare that could be electronically jammed (184)
- In 1963 the Army began withdrawing the Lacrosse due to lack of funding. The last missile was deactivated in February, 1964 (184)

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W45 Little John Missile (SRBM)

Figure 64 *LITTLE JOHN short-range rocket*

Hansen 6:278

General Specifications of Warhead

- **Dimensions:** Length: 2 ft 3 in
  Diameter: 11.75 in
  Weight: 150 lbs
  (Polmar and Norris 55)
- **Yield:** Kiloton class (55)
- **Inventory:** Mods 2, 3 Little John Mar 1962-1965 (55)
- **Weapons:** Little John surface-to-surface missile (55)
- Relatively small warhead employed mainly in tactical missiles (55)

History of Warhead

- By the summer of 1956, the AEC planned a 10" to 12" diameter low-yield warhead for the LITTLE JOHN (Hansen 6:284)
- MK45/LITTLE JOHN weapon system was declared operational in March 1962 and the MK45 Mod 2 warhead was design-released at the end of February 1964 (289)
- The W45s for the LITTLE JOHN were manufactured between January 1962 and June 1966; all were retired between July 1967 and the end of 1970 (289)

General Specifications of Missile

- **Operational:** Nov 1961—Aug 1969
- **Dimensions:** Length: 14 ft 5 in
  Diameter: 1 ft .5 in
  Weight: 730 lbs
  (Polmar and Norris 232)
- **Range:** 12.5 miles (232)
- **Solid Fuel** (232)

Little John Rocket (*White Sands*)

History of Missile

- On October 28, 1953 the Joint Chiefs of Staff requested the Secretary of Defense to develop a lightweight atomic demolition munition with possible application to other weapons requiring a small warhead (Hansen 6:277)
- LITTLE JOHN JR rocket was to be a small free-flight system carrying a small atomic warhead to a maximum range of at least 20,000 yards and a minimum range of 3,500 yards (279)
- It was the smallest nuclear capable rocket ever deployed by the U.S. Army (Gibson 185)
- Could be easily lifted by helicopters (Polmar and Norris 232)
- 20 August 1969, the last rocket was withdrawn from service without any official reason (Gibson 186)

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W52 Sergeant Missile (SRBM)

Hansen 6:319

General Specifications of Warhead

- **Dimensions:** Weight 950lbs (Hansen 6:318)
- **Yield:** Kiloton class (318)

History of Warhead

W52 Sergeant Missile

- In mid-January 1959, Sandia notified the AEC that a SERGEANT warhead could be developed by August 1961, and military characteristics were approved by the MLC on January 20 (Hansen 6:316)
- The development nomenclature of XW52 was assigned to the new warhead (316)
- Production of the MK52 Mod 1 warhead started in May 1962 and the MK52 Mod 2 warhead was design-released at the end of January 1963. Production commenced the following month (318)
- Manufactured between May 1962 and April 1966 (319)
- Retired between March 1974 and August 1978 (319)

General Specifications of Missile

- **Operational:** July 1962—May 1977
- **Dimensions:** Length: 34 ft 6 in
  Diameter: 2 ft 7 in
  Weight: 10,100 lbs
  (Polmar and Norris 237)
- **Range:** 100 miles (237)
- **CEP:** High Accuracy (Gibson 186)
- **Solid Fuel**

Sergeant Missile (*White Sands)*

History of Missile

- First solid fuel surface-to-surface missile ever deployed by the U.S. Army (Gibson 187)
- Half as large as the Corporal and was much safer (Polmar and Norris 237)
- Could be launched in less than 90 minutes (237)
- One unusual characteristic of the SERGEANT missile was the inclusion and use of four large, hydraulically-deployed drag brakes on the outside of the rocket, somewhat similar to the brakes on the early Army DEMIJOHN rocket. These brakes were used for range control; the solid-fueled SERGEANT motor could not be shut off quickly after it began burning (Hansen 6:321)
- Eventually replaced by the Lance. The last Sergeant missile was retired in May 1977 (Polmar and Norris 237)

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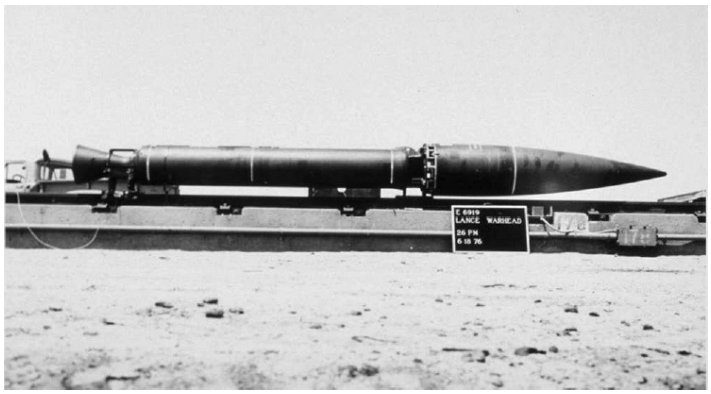
W70 Lance Missile (SRBM)



W70 Warhead (Hansen 6:323)

General Specifications of Warhead

- **Dimensions:** Length: 3 ft 5 in
  Diameter: 1 ft 6 in
  Weight: 465 lbs
  (Polmar and Norris 64)
- **Yield:** sub-Kiloton (64)
- **Inventory:** 1973 – 1991 (64)
- **Weapons:** Lance battlefield missile (64)

History of Warhead

- The W70 was the warhead for the Army's LANCE missile, which replaced the SERGEANT as the Army's chief tactical nuclear missile (Hansen 6:321)
- Production engineering commenced in December 1970 and the first production units of the W70 Mods 0/1/2 appeared in June 1973. Quantity production continued until July 1977 (321)
- Retirement of these mods started in July 1979 and was completed by September 1992 (321)
- Development and production engineering of the W70 Mod 3, an "enhanced radiation" version of the W70, began in April 1976 and was suspended for political reasons by the Carter administration at the end of September 1977. Production engineering was resumed on November 1, 1978 and the first production units were completed by May 1981 (322)
- The weapon could be fused for either air or surface burst with variable height-of-burst (for airbursts, a "backup" contact burst capability was included) (322)
- By March 1991, a retirement schedule for the W70-3 had been established and the last unit was retired by September 1992 (322)

General Specifications of Missile

- **Operational:** July 1972-1992
- **Dimensions:** Length: 20 ft 3 in
  Diameter: 1 ft 10.25 in
  Weight: 2,834 lbs
  (Polmar and Norris 232)
- **Range:** 71 miles (232)
- **CEP:** Approximately 1000 ft (Gibson 188)

Lance Missile (*White Sands*)

History of Missile

- Dual Capable, short range, all-weather missile developed for the U.S. Army (Polmar and Norris 231)
- The last battlefield nuclear missile to be deployed by the U.S. Army (Gibson 188)
- Began deployment in 1976 to Western Europe (Polmar and Norris 231)
- Since 1992, the Lance missile has only been in service with U.S. allies (Gibson 189)

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W50 Pershing I (MRBM)

U.S. Army

General Specifications of Warhead

- **Dimensions:** Length: 3 ft 8 in
  Diameter: 1 ft 3.75 in
  Weight: 410 lbs
  (Polmar and Norris 57)
- **Yield:** Kiloton class (57)
- **Inventory:** 1964 – 1990 (57)
- **Weapons:** Pershing Ia surface-to-surface missile (57)

History of Warhead

- On November 14, 1956, the Army Ballistic Missile Agency (ABMA) was tasked with the study of the development of 100-750 nautical mile range missile system with a 500-600 lb. nuclear warhead, a CEP of 500 meters (1,640 ft.) and an operational readiness date of 1956 (Hansen 6:303)
- The warhead would be capable of either air or surface bursts. In addition to the W50 warhead, the PERSHING warhead section would house the adaption kit, spin system, fusing devices, and its own power supply (306)
- A new MK50 mod with a Category A PAL (containing a four-digit MC 1541 electromechanical coded switch) was designated MK50 Mod 1 (310)
- Initial production of MK 50 Mod 1 warheads for the PERSHING started in March 1963 and were manufactured between then and December 1965 (311)
- The W50 featured three yields (W50Y1, Y2, and Y3): in a number of warhead sections.
- The last W50 was retired by April 1991 (311)

Pershing I (*White Sands*)

General Specifications of Missile

- **Operational:** June 1964--1990
- **Dimensions:** Length: 34 ft 6 in
  Diameter: 3 ft 4 in
  Weight: 10,275 lbs
  (Polmar and Norris 235)
- **Range:** 115-460 miles (235)
- **CEP:** few hundred meters (Hansen 6:312)

History of Missile

- Created as a replacement for the Redstone (Polmar and Norris 234)
- First solid fuel Medium Range Ballistic Missile to be deployed by the U.S. Army
- Army PERSHING Ia's were replaced by PERSHING IIs with W85 warheads starting in December 1983 (Hansen 6:311)
- All were replaced by 1985 (Gibson 173)
- Pershing I missiles were banned through the INF treaty and the last Pershing I missile was destroyed on 6 July 1990 (Polmar and Norris 234)

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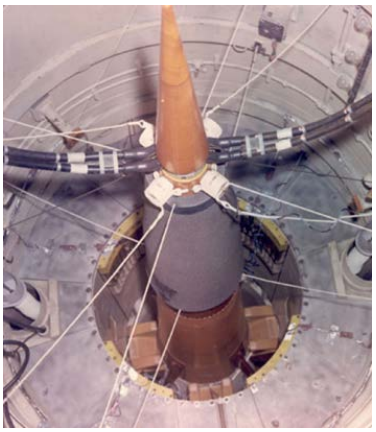
W66 Sprint Missile (SRBM)



Sprint Missile (*White Sands*)

General Specifications of Warhead

- **Dimensions:** Length: 2 ft 11 in
  Diameter: 1 ft 6 in
  Weight: 150 lbs
  (Polmar and Norris 63)
- **Yield:** Kiloton class (63)
- **Inventory:** cancelled (63)
- **Weapons:** Sprint anti-ballistic missile (63)

History of Warhead

- Production engineering of the W66 began in January 1972 with the first production units appearing in June 1974. The W66 warheads were fabricated between October 1974 and March 1975 (Hansen 6:181)
- The W66 was an "enhanced radiation" warhead that "killed" its target through neutron flux. Both the W66 warhead for the SPRINT and the W71 for the SPARTAN were developed exclusively during underground nuclear tests (182)
- These weapons were "officially" retired in 1985 after being in storage for almost ten years (181)

General Specifications of Missile

- **Operational:** Oct 1975-1976 (Polmar and Norris 215)
- **Dimensions:** Length: 27 ft
  Diameter: 4 ft 6 in
  Weight: 7600 lbs (215)
- **Range:** 25 miles (215)
- **Speed:** Hypersonic / Mach 10 + (Gibson 210; Morgan and Berhow 64)

History of Missile

- The Sprint missile was the third anti-ballistic missile to be developed by the U.S. (Gibson 211)
- Following cancellation of the NIKE ZEUS in 1959, the Secretary of Defense on January 3, 1963 called for the priority development of a new ABM defense system—the SAFEGUARD/SPARTAN and SAFEGUARD/SPRINT (Hansen 6:180)
- In 1967, the Secretary of Defense announced the development of a Sentinel system to protect the United States from the threat of Chinese ICBMs. The Chinese exploded their first nuclear weapon in 1965 (Morgan and Berhow 64)
- The system eventually evolved into a two-tier defense with large, long-range Mach 10 SPARTAN interceptors to destroy enemy ICBMs at distances up to 100 mile. The smaller, high-acceleration

SPRINT missiles were a "last ditch" low-altitude defense to catch any RVs/RBs up to a range of 25 miles that broke through the SPARTAN line (Hansen 6:180)

- The system involved not only new missiles, but also new radars and computers to discriminate between incoming warheads, chaff, and decoys (180)
- On March 14, 1969 Sentinel was renamed Safeguard and formally entrusted with the safety of America's continental, nuclear deterrent forces (Morgan and Berhow 64)
- The missile was able to withstand a mechanical shock of 25,000 G's and was the fastest missile fielded (Gibson 211 and 213)
- 23 December 1970 a Sprint missile successfully intercepted its first ICBM (Gibson 212)
- Decommissioned in 1976 (Lennox 578)

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W47 Polaris A1 & A2 (SLBM)

Hansen 6:188

General Specifications of Warhead

- **Dimensions**: Length: 56.6 in
  Weight: Approximately 700 lbs
  Diameter: 18 in
  (Hansen 6:440)
- **Yield**: Kiloton Class (440)

History of Warhead

- The W47 warhead for the Navy's first fleet ballistic missile, the POLARIS, was the first modern, high-yield, lightweight nuclear warhead (Hansen 6:365)
- W47s for the POLARIS A-1 and A-2 Fleet Ballistic Missiles (FBM) were manufactured between June 1960 and July 1964 (441)
- All were retired between July 1961 and November 1974 but all W47s were not in the stockpile at one time. Early mods were retired as later mods were manufactured (441)

General Specifications of Polaris A-1

- **Dimensions:** Length: 28 ft
  Diameter: 4.3 ft
  Weight: 28,000 lbs
  (Lennox 557)
- **Range:** 1400 miles (557)
- **CEP:** Approximately 6000 ft (557)
- **Solid Fuel / 2 Stage** (557)

General Specifications of Polaris A-2

- **Dimensions:** Length: 31.1ft
  Diameter: 4.49 ft
  Weight: 30,000 lbs
  (Lennox 557)
- **Range:** 1800 miles (557)
- **CEP:** Approximately 4000 ft (557)
- **Solid Fuel / 2 Stage** (557)

History of Missile

- The Polaris SLBM was the first nuclear tipped strategic ballistic missile ever deployed on U.S. Navy submarines (Gibson 33)
- The POLARIS program adopted the then-unique and unconventional approach of integrating both AEC and DOD components, items which were designed and fabricated from materials useful for both structural integrity and thermal protection (Hansen 6:378)
- 1st flight test of Polaris missile in 1958 (Lennox 556)
- On 6 May 1962, the Ethan Allen launched a live Polaris A-1 at the Pacific Nuclear Test Range to mark the only live firing of a U.S. strategic missile (Gibson 34)
- After 1961, all efforts focused on developing the Polaris A-2 (Gibson 34)
- 1st flight test of Polaris A-2 occurred in 1961 (Lennox 556)
- The last Polaris A-2 patrol took place in June 1974 (556)

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W58 POLARIS A-3 (SLBM)

USS Holland AS-32 Association

General Specifications of Warhead

- **Dimensions:** Length: 3 ft 4 in
  Diameter: 1 ft 3.5 in
  Weight: 257 lbs
  (Polmar and Norris 60)
- **Yield:** Kiloton class (60)
- **Inventory:** Mar 1964 – 1981 (60)
- **Weapons:** Polaris A-3 SLBM (60)
- Only multiple reentry vehicle warhead to be deployed on a U.S. missile (60)

History of Warhead

- One way to overwhelm anti-ballistic missile defenses was by using Multiple Reentry Bodies (MRBs), a cluster of warheads carried by the same re-entry vehicle and dispersed like shotgun pellets over a five-mile area, landing in a tight pattern centered on the aiming point. The dispersion area was called a "footprint" (Hansen 6:445)
- Three of these clustered W58 warheads aboard a POLARIS A-3, arcing down in a triangular "footprint" over their target, would offer the same destructive force as a single megaton weapon. The spread of the "footprint" would avert destruction of more than one RB by a single ABM (450)
- Nominal airburst fusing altitude was 10,000 feet (459)

General Specifications of Missile

- **Dimensions:** Length: 31.1 ft
  Diameter: 4.5 ft
  Weight: 30,000 lbs
  (Lennox 557)
- **Range:** 2900 miles (557)
- **Solid Fuel** (557)
- **CEP**: Approximately 3000 ft (557)

History of Missile

- Entered development phase in 1960 and was tested in 1962 (Lennox 556)
- Equipped with the first operational Multiple Re-Entry Bodies with 3 RBs, designed to increase the lethal blast area (556)
- The last Polaris A-3 patrol took place in 1981 (556)
- Replaced by the Poseidon (Gibson 35)

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W68 POSEIDON - MK3 Reentry Body (RB) (SLBM)

USS Holland AS-32 Association

General Specifications of Warhead

- **Dimensions:** Weight: 367 lbs (Polmar and Norris 63)
- **Yield:** Kiloton class (63)
- **Inventory:** 1970 – 1991 (63)
- **Weapons:** Poseidon C-3 SLBM (63)
- First U.S. missile to become operational with a MIRB (multiple independently targetable reentry body) warhead (63)

History of Warhead

- The W68 was a small Livermore warhead for the POSEIDON MK 3 RB (Hansen 6:460)
- Designed from the start to be a MIRB (Multiple Independently-Targeted RB) system with several warheads on each missile, all targeted against a single location or each targeted on a separate site. It would allow the lightest warhead/reentry vehicle combination yet (deployed). Weight restrictions were severe, since up to 14 RBs might be deployed on a single POSEIDON C-3 missile, a consequence of its intended deployment in a possible Soviet anti-ballistic missile system environment (460-1)
- Fabrication of the W68 ended in June 1975 (462)
- Most numerous of any single U.S. nuclear warhead (462)
- Retirement of early mods began in September 1977 and all had been taken out of service by the fall of 1991. The last W-68 was retired during FY 1993 (October 1992 - September 1993) (462)

General Specifications of Missile

- **Dimensions:** Length: 34 ft 1.2 in
  Diameter: 8 ft
  Weight: 64,400 lbs
  (Gibson 36)
- **Range:** 2880 miles (36)
- **CEP:** Approximately 2000 ft (36)
- **Solid Fuel** / **2 Stage** (36)

History of Warhead

- First MIRBed submarine launched ballistic missile ever deployed (Gibson 36)
- Marked a 100 fold increase in US SLBM force capability (36)
- Missile became operational in March 1971 (Lennox 563)
- All C-3 Poseidon missiles have been removed from operational service (563)

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Poseidon. Photograph. USS Holland AS-32 Association. USS Holland AS-32 Association. Web. 5 June 2012. < http://www.ussholland.org/boatlink.html>.

W76 Trident I (SLBM)

Hansen 6:466

General Specifications of Warhead

- **Dimensions:** Weight: 212 lbs (Polmar and Norris 65)
- **Yield:** Kiloton class (65)
- **Inventory:** 1979 – current (65)
- **Weapons:** Trident C-4 SLBM
  Trident D-5 SLBM (65)

History of Warhead

- The W76 is a small Los Alamos warhead for the TRIDENT I (C-4) MK 4 RB (Hansen 6:465)
- Following deployment of the relatively-low yield W68, the Navy sought development of a higher-yield warhead for the TRIDENT and the TRIDENT I was now to carry eight RBs instead of 10 (468)
- Development engineering of the W76 began in May 1973 and production engineering started in November 1975. The first production units were completed by June 1978; quantity production began in November 1978 and was completed by July 1987 (468)
- In Spring of 1999, the W-76 was undergoing a service life extension program to maintain its deployment into the 21st century (468)
- MK 4 RB CEP is on the order of 400-500 yards over a range of 4,500 nautical miles (5,175 statute miles) (469)
- The W76/TRIDENT I's were to have eventually been retired and replaced by the W88/TRIDENT II (D-5) weapon system; however, the closure of the Rocky Flats pit fabrication plant in 1990 ended W88 production (469)

General Specifications of Missile

- **Dimensions:** Length: 34 ft 1.2 in
  Diameter: 6 ft 2 in
  Weight: 73,000 lbs
  (Gibson 38)
- **Range:** 4600 miles (38)
- **CEP:** Approximately 1250 ft (38)

History of Missile

- First U.S. Navy Submarine Launched Ballistic Missile that could reach Soviet territory from a U.S. port (Gibson 38)
- Navy needed a longer range capability to improve survivability of the launching submarines (38)
- 20 October 1979—the Francis Scott Key went on its first Trident I patrol (38)
- Trident I was deployed to allow the U.S. to meet its commitment to Spain and end its FBM operations at Rota, Spain by 1979 (39)

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W88 Trident II (SLBM)

U.S. Navy

General Specifications of Warhead

- **Dimensions:** Weight: 500 - 600 lbs (Polmar and Norris 70)
- **Yield:** Kiloton class (70)
- **Inventory:** 1990 – current (70)
- **Weapons:** Trident II D-5 SLBM (70)
- President George H.W. Bush announced in his State of the Union message on 28 January 1992 that the U.S. would end production of the W88 warhead, but the Department of Energy reestablished small-scale warhead pit production at Los Alamos (70)

History of Warhead

- The W88 is the Los Alamos warhead for the TRIDENT II (D-5) missile with the MK 5 RB (Hansen 6:469)
- By early 1984, the TRIDENT II was to carry up to ten warhead / RB pairs derived from the LANL W87/MK 21 RV combination used on the Air Force's MX (PEACEKEEPER) ICBM (469)
- IOC for the W88 was in June 1989 and the W88s were in stockpile by mid-1990 (470)
- By the spring of 1991, the Navy had enough warheads on hand to equip four TRIDENT submarines (470)
- The W88 is similar to the W87 and uses a higher yield to attack "hardened" targets (471)
- The last W88 warhead was assembled on July 31, 1990 (474)
- The shutdown in November 1989 of the DOE's Rocky Flats, Colorado, plutonium processing facility (due to safety and environmental contamination problems) put a halt to W88 production (475)

General Specifications of Missile

- **Dimensions:** Length: 44 ft 6.6 in
  Diameter: 6 ft 11 in
  Weight: 130,000 lbs
  (Gibson 40)
- **Range:** 4606 miles + (40)
- **CEP:** Approximately 130 yards (Hansen 6:471)

History of Missile

- Largest SLBM the U.S. has attempted since the solid fueled Jupiter IRBM of 1956 (Gibson 40)
- Development began in 1966 (40)
- Increased patrol area of submarines (42)
- 31 March 1990—Trident II became operational (42)
- START II limited U.S. to only 432 SLBM launchers, or 18 Trident submarines (42)

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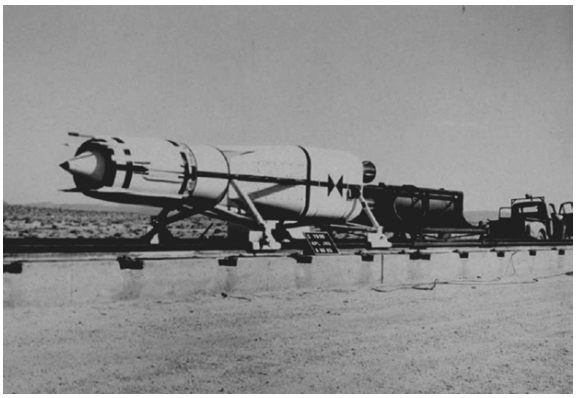
W30 TALOS



Hansen 6:152

General Specifications of Warhead

- **Dimensions:** Length: 4 ft
  Diameter: 1 ft 10 in
  Weight: 438 - 490 lbs
  (Polmar and Norris 50)
- **Yield:** Kiloton class (50)
- **Inventory:** Feb 1959 – Mar 1979 (50)
- **Weapons:** TALOS surface-to-air missile (50)

History of Warhead

- In early January 1954, the MLC requested consideration of a new 280-lb. nuclear warhead for the Navy's TALOS missile (Hansen 6:144)
- Safety devices and techniques were emphasized to insure positive warhead control at all times: in storage, on alert, and in flight. These new small air defense warheads were relatively inefficient but nuclear efficiency was not as important in 1955 as it was just three years earlier (144 and 150)
- The XW30 was expected to be available for operational use by July 1958 (150)
- The TALOS could engage targets at ranges up to 100 miles; its performance was so much better than the NIKE that the Air Force still wanted to use the TALOS for airbase defense (150)
- The XW30 entered production engineering in March 1957. The W30 Mod 0 warhead design was released for production in January 1958 (151)
- Production and stockpiling of the W30 Mod 0 warhead for the TALOS began in February 1959 and was manufactured until production ended in January 1965 (151)
- All the W30/TALOS weapons were retired between January 1962 and March 1979 (153)

General Specifications of Missile

- **Operational:** 1958-1979
- **Dimensions:** Length: 38 ft
  Diameter: 2 ft 4 in
  Weight: 3400 lbs
  (Polmar and Norris 222)
- **Range:** 70 miles (222)

TALOS (*White Sands*)

History of Missile

- Large size of TALOS missile and its magazine, handling, and fire control equipment only permitted its installation in large, cruiser-type ships (Polmar and Norris 221)
- Most powerful missile to come out from the Bumblebee program (Gibson 197)
- Due to its high efficiency trajectory, the missile attacked from above and provided a tactical advantage (198)
- Developed to counter Japanese kamikaze attacks in the Pacific (Polmar and Norris 221)
- IOC: 1958 (222)

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Talos. Photograph. White Sands Missile Range Museum, White Sands Missile Range Museum, NM. White Sands Missile Range Museum. White Sands Missile Range Historical Foundation. Web. 6 June 2012. <http://www.wsmr-history.org/Talos.htm>.

W34 ASTOR Torpedo

Hansen 5:528

General Specifications of Warhead

- **Dimensions:** Length: 2 ft 8 in
  Diameter: 1 ft 5 in
  Weight: 311 - 320 lbs
  (Polmar and Norris 51)
- **Yield:** Kiloton class (51)
- **Inventory:** 1960 – 1977 (51)
- **Weapons:** Mk 34 / ASTOR torpedo (51)

History of Warhead

- During 1956, it was concluded that the best counter to a growing Soviet submarine threat was anti-submarine weapons armed with nuclear warheads. Development was advocated of a non-homing nuclear torpedo, by fitting the W34 warhead to existing naval submarine torpedoes (Hansen 5:524)
- The LULU warhead (the XW34) could be adapted to a standard 21-inch diameter torpedo warhead. This would provide an interim nuclear torpedo capability for submarines, until the advanced torpedo became available (524)
- MK34/ASTOR production was authorized in March 1959 and the MK34 Mod 1 and 2 warhead was design-released for application to the ASTOR torpedo in September 1960 (526)
- The W34/LULUs and W34/ASTORs were retired between July 1964 and September 1977; the last ASTOR was withdrawn in 1976 (527)

General Specifications of Missile

- **Operational:** 1963-1976
- **Dimensions:** Length: 18 ft
  Diameter: 19 ft
  (Polmar and Norris 250)
- **Range:** 15,000 yds (250)

History of Missile

- The ASTOR was the first U.S. nuclear weapon system to be retired in favor of a non-nuclear system (Hansen 6:527)
- Only torpedo with a nuclear warhead developed in the West (Polmar and Norris 248-9)
- Development began in 1957 and approved for service in 1961 (249)
- Sailors made jokes that the torpedo had a probability of kill of 2, both the target and launching submarines (249)
- Was quickly obsolete because of its command guidance system. Commands were transmitted through a wire attached to the torpedo (Gibson 219)
- Replaced by the Mk 48 torpedo with a conventional warhead (Polmar and Norris 249)

Sources

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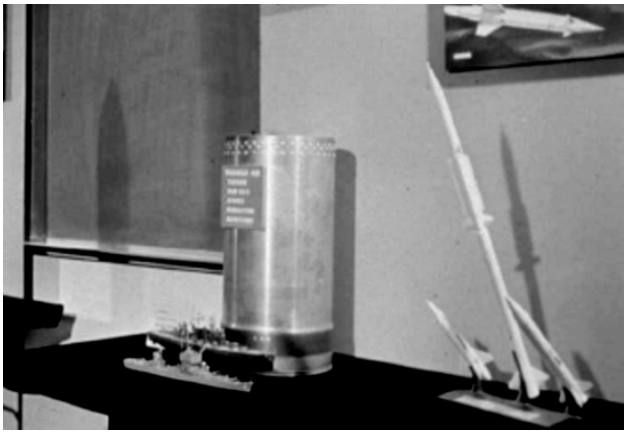
W45 TERRIER



Hansen 6:168

General Specifications of Warhead

- **Dimensions:** Length: 2 ft 3 in
  Diameter: 11.75 in
  Weight: 150 lbs
  (Polmar and Norris 55)
- **Yield:** Kiloton class (55)
- **Inventory:** Oct 1962 – 1987 (55)
- **Weapons:** Terrier surface-to-air missile (55)

History of Warhead

- The W45 used on the Air Force's BULLPUP air-to-surface missile was also married to the Navy's BT-3A(N) TERRIER air-defense missile (Hansen 6:167)
- On August 10, 1955, the DMA requested that the W45 warhead be considered for use on the TERRIER missile. FCDASA released a feasibility study of a small-diameter warhead on November 1, and development engineering was authorized on January 27, 1956 (167)
- UCRL developed the warhead for the TERRIER. W45 development stretched out for several years between 1956 and 1961, interrupted by the 1958-1961 nuclear test moratorium (167)
- Production engineering of the W45 began in October 1959. Early production of the W45 Mod 1 warhead started in April 1962 and the W45/TERRIER weapon system achieved operational availability in October. W45s for the TERRIER were manufactured between April 1962 and June 1966 (167)
- Retirement of early mods started in July 1967. The last W45 on a TERRIER was retired in September 1988. Plans were made to replace TERRIERs with the STANDARD-2 missile with the W-81 warhead; however, Congress never approved development of the new warhead (168)

General Specifications of Missile

- **Operational:** 1962-1989
- **Dimensions:** Length: 13 ft 6 in
  Diameter: 1 ft 1 in
  Weight: 1180 lbs
  (Polmar and Norris 223)
- **Range:** 20+ miles (223)
- **Solid Fuel** (223)

Terrier (*White Sands*)

History of Missile

- The Korean War ensured that the Terrier missile deployed (Gibson 203)
- Terrier missiles were installed on U.S aircraft carriers, cruisers, and destroyer-type ships as well as Italian cruisers (Polmar and Norris 222)

- By 1992, all Terrier nuclear warheads had been removed from Navy surface ships (Gibson 204)
- During Vietnam at least 3 North Vietnamese Mig-type aircraft were shot down by Terrier missiles with conventional warheads installed (Polmar and Norris 223)

Sources

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Terrier. Photograph. White Sands Missile Range Museum, White Sands Missile Range Museum, NM. *White Sands Missile Range Museum*. White Sands Missile Range Historical Foundation. Web. 6 June 2012. <http://www.wsmr-history.org/Terier.htm>.

W49 Jupiter - Thor - Atlas

General Specifications

- **Yield:** Megaton class (Hansen 6:297)

Jupiter Missile (Federation of American Scientists)

History of Warhead

- As early as February 1954, missile warheads weighing less than 3,000 lbs. and yielding one to two megatons were foreseen (Hansen 6:291)
- The first MK 49 Mod 0 warheads entered the stockpile in September, 1959. Initial operational capability of the THOR began in November 1959. The W49 went from Phase 3 to Phase 4 in one month and from Phase 4 to Phase 6 in eight months. The W49 was in production for 28 months, during which units were manufactured for the THOR, JUPITER, and ATLAS D missiles (298-9)
- The W49 began retirement 201 months (approximately 17 years) after production started. Most of the remaining THORs with W49 warheads were retired between the end of November 1962 and mid-August 1963; a few were kept until April 1975 as a ground-based anti-satellite missile system based on Johnston Island (300)

General Specifications of Missile

Jupiter

- **Dimensions:** Length: 60 ft 1 in
  Diameter: 8 ft 9 in
  Weight: 109,000 lbs
  (Polmar and Norris 169)
- **Range:** 1,750 miles (169)
- Liquid fuel (169)

Thor Missile (Boeing)

Thor

- **Dimensions:** Length: 64 ft 10 in
  Diameter: 8 ft
  Weight: 110,000 lbs
  (Polmar and Norris 181)
- **Range:** 1,740 miles (181)
- Single stage liquid propellant (181)
- **Inventory:** 9 Dec 1959 – Sep 1963 (181)

Atlas

- **Dimensions:** Length: 81 ft 7 in
  Diameter: 10 ft
  Weight: 267,136 lbs
  (Polmar and Norris 166)
- **Range:** 6,325 miles (166)
- **Inventory:** Sep 1959 – Sep 1964 (166)

Mercury Atlas preparing for launch
(NASA)

History of Missile

Jupiter

- The Army's IRBM project was named JUPITER. JUPITER was 105 inches in diameter and 58 feet long, with a nose cone section that weighed 2,617 lbs. fully loaded. The missile was to carry a 1,600 lb. warhead to a range of 1,500 miles with a 0.81 nautical miles CEP. The ablative nose cone contained the warhead, fusing and arming device, and related power equipment (Hansen 6: 293-4)
- The Jupiter was the U.S. Army's entry into the intermediate range ballistic missile field (Polmar and Norris 168)
- Developed in competition with Thor (168)
- Secretary Wilson issued directive in 1956 stating that land-based IRBMs would be the responsibility of the Air Force, not the Army (168 – 169)
- Obsolete by the time they deployed (169)
- Became operational in 1961. Dismantled in 1963 by a special directive from President Kennedy in the wake of the Cuban Missile Crisis (169)

Thor

- Plans called for a 1,500 mile range IRBM carrying a 2,000 lb. payload. The missile would have a diameter of 95 inches (just under eight feet) and a length of 1,124 inches (just under 94 feet). The missile was to be named THOR; it was then an eight-foot diameter, 65-foot long, 1,750 mile range weapon. The missile would use the ATLAS's GE MK 2 heatsink re-entry vehicle (Hansen 6: 291- 292)
- Initiated in Nov 1955 because the Air Force was institutionally incapable of accepting an Army-designed missile (Polmar and Norris 179)
- Thor was also deactivated and discarded after the Cuban Missile Crisis because it used liquid fuel (181)
- Served as the 1st stage booster for the U.S. Pioneer moon rocket launched on 11 Oct 1958 (181)

Atlas

- The Atlas D became operational on 9 Sep 1959 and was the first operational U.S. ICBM (Polmar and Norris 165)
- Atlas 10-B attained orbit with the Project Score payload on 18 December 1958, becoming the world's first communications satellite (165)

Sources

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W38 Atlas / Titan I

Hansen 6:265

General Specifications of Warhead

- **Dimensions:** Length: 6 ft 10.5 in
  Diameter: 2 ft 8 in
  Weight: 3,080 lbs
  (Polmar and Norris 52)
- **Yield:** Megaton class (52)
- **Inventory:** Atlas E: Oct 1961 – Mar 1965
  Atlas F: Sep 1962 – Apr 1965
  Titan I: Apr 1962 – Apr 1965 (52)
- **Weapons:** ICBM (52)

History of Warhead

- In July 1955, authorization was issued to both LASL and UCRL to proceed with parallel designs for an ATLAS thermonuclear warhead (Hansen 6:262)
- On January 19, 1956, the nomenclature of XW38 was assigned to the UCRL proposal. The XW38 design was expanded in March to include applications to the TITAN ICBM and the THOR and JUPITER IRBMs (262)
- The first W38 warhead was manufactured in May 1961. ATLAS E/F W38 warheads and TITAN I W38 warheads were produced between May 1961 and January 1963 (264)
- The MK 4 was deployed with the ATLAS and TITAN I between 1960 and 1962 (264)
- The MK 4/W38 assembly was fused for either impact or air burst (264)
- ATLAS CEP had been reduced from 30,300 feet in 1958 to only 910 feet by 1962 (264)
- All were retired between January and May 1965 (264)

General Specification of the Atlas E and F

- **Operational:** Sep 1961—Mar 1965
- **Dimensions:** Length: 81 ft 7 in
  Diameter: 10 ft
  Weight: 267,136 lbs
  (Polmar and Norris 166)
- **Range:** 7800 miles (166)

Titan I (*USAF Museum*)

History of Missile

- The Atlas E was deployed in a semi-hard concrete coffin-type launcher buried in the ground (Polmar and Norris 166)
- The Atlas F was deployed in a hardened silo (167)
- Last Atlas E ICBMs were removed in March 1965 and the last Atlas F ICBMs were removed in April 1965 (167)

Sources

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Titan I Missile Elevated for Launch. Photograph. USAF Museum Photo Archive. *Colorado Department of Public Health and Environment*. Colorado Department of Public Health and Environment. Web. 6 June 2012. <http://www.cdphe.state.co.us/hm/titanmissiles.htm>.

W53 Titan II (LGM-25C) ICBM

Hansen 6:326

General Specifications

- **Dimensions:** Length: 8 ft 7 in
  Diameter: 3 ft 1 in
  Weight: 6,200 lbs
  (Polmar and Norris 58)
- **Yield:** Megaton class (58)
- **Inventory:** 1962 – May 1987 (58)
- **Weapons:** Titan II ICBM (58)
- The W53 was the largest warhead carried by a U.S. strategic missile (58)

History of Warhead

W53 Titan II (LGM-25C) ICBM

- W53 warheads for the TITAN II were produced between December 1962 and December 1963 (325)
- Was the most powerful ICBM warhead ever deployed by the U.S. (325)
- Largest nuclear warhead in the U.S. missile arsenal (Polmar and Norris 182)
- Retirement began in October 1969 and the last W53 TITAN II was retired by September 1987 (Hansen 6: 264)

General Specifications of Missile

- **Dimensions:** Length: 103 ft
  Diameter: 10 ft
  Weight: 327,000 lbs
  (Polmar and Norris 183)
- **Inventory:** Oct 1963 – May 1987 (183)
- **Range:** 8,400 miles (183)
- Liquid propellant/ 2 stage (183)

History of Missile

- The TITAN missile had great growth potential because it was capable of very large warheads — up to 5,500 lbs. to 5,500 nautical miles, or to extraordinary ranges — warheads up to 1,600 lbs. to 8,500 nautical miles (Hansen 6:323)
- The TITAN II was to carry a 7,500 lb., megaton warhead, which could be used against large cities and "hardened" targets. The new missile could also carry penetration aids, including decoys and electronic countermeasures, including chaff and jammers, to passively and actively jam enemy anti-missile radars (324)
- Largest U.S. ICBM to be developed and deployed. It weighed almost 5x as much as the Minuteman (Polmar and Norris 182)
- Weighed 50% more than the Titan I (182)
- Titan II had a history of fires, accidents, and fuel leaks (182)

Sources

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W59 Minuteman I ICBM

General Specifications

- **Dimensions:** Length: 3 ft 11.75 in
  Diameter: 1 ft 4 in
  Weight: 550 lbs
  (Polmar and Norris 60)
- **Yield:** Megaton class (60)
- **Inventory:** Oct 1962 – Jan 1969 (60)
- **Weapons:** Minuteman IA ICBM (60)
- The first Minuteman IA missile went on alert during the Cuban missile crisis, October 1962 (60)

Minuteman Missile (*Strategic Air Command*)

History of Warhead

- On November 23, 1960 the DDRE directed the AEC to develop a new LASL design as the initial warhead for the MINUTEMAN and provide the XW56 as a follow-up application (Hansen 6:340)
- On December 9, 1960, the Air Force suggested that a lighter and higher-yield LASL design replace the XW56 for early application to the MINUTEMAN (340)
- The Air Force planned to use the Mark 5 RV/XW59 warhead combination on the first MINUTEMAN wing (which became operational in December 1962 at Malmstrom AFB in Montana) and the Mark 11/XW56-X1 combination for the second and subsequent wings (341)
- The MK 59 Mod 0 warhead design was released at the end of November 1961 and production started in June 1962. W59s for the MINUTEMAN I were produced between June 1962 and July 1963 (341)
- All were retired between December 1964 and June 1969 (341)

General Specifications of Missile

- **Dimensions:** Length: IA - 53 ft 8 in IB – 55 ft 9 in
  Diameter: 6 ft 1 in
  Weight: 69, 920 lbs
  (Polmar and Norris 172)
- **Inventory:** Minuteman IA: 11 December 1962 – 1974 Minuteman IB: 30 Sep 1963 - 1974 (172)
- **Range:** 7,250 miles (172)

History of Missile

- Most numerous U.S. strategic missile. 1,000 missiles deployed at the height of the Cold War (Polmar and Norris 171)
- Second US solid propellant strategic missile to become operational (171)
- The world's first solid fuel ICBM (Gibson 17)

Sources

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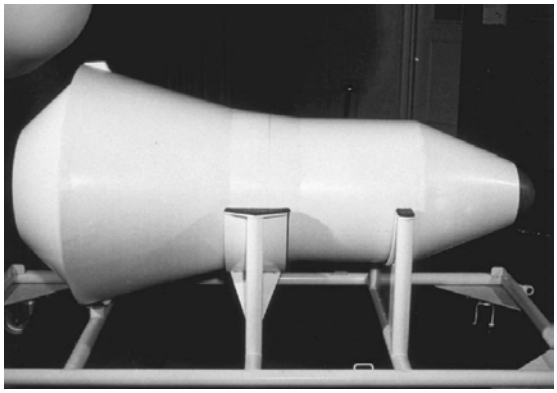
W56 Minuteman I ICBM and Minuteman II (LGM-30F) ICBM

General Specifications

- **Dimensions:** Length: 3 ft 11 in
  Diameter: 1 ft 5.5 in
  Weight: 680 lbs
  (Polmar and Norris 59)
- **Yield:** Megaton class (59)
- **Inventory:** Minuteman IB 1963 – 1969
  Minuteman II 1966 – 1991 (59)
- **Weapons:** Minuteman ICBM (59)



Hansen 6:341

History of Warhead

- Production started in 1963 (Hansen 6:338)
- The MK 11C RV was 97" long and 32" in diameter; it had an 8-target selection capability, MK-1/1A penetration aid canisters, and was "hardened" against nuclear weapons effects (339)
- The warhead was fused for airburst with contact backup or contact burst (339)
- W56 Mod 4s remained in service with the Air Force as of mid-1991; remaining MINUTEMAN IIs were slated for retirement beginning in October 1, 1991 (Hansen 6:340)
- The last W56 was retired sometime between October 1992 and March 1993 (340)

General Specifications of Missile

- **Dimensions:** Length: 55 ft 9 in
  Diameter: 5 ft 6 in
  Weight: 72, 090 lbs
  (Polmar and Norris 172)
- **Inventory:** 25 Apr 1966 – 28 Sep 1991 (172)
- **Range:** 7,750 miles (172)
- **CEP:** Approximately 1,500 ft (172)

National Park Service

History of Missile

- The LGM-30F Minuteman-II was an improved version of the Minuteman-I missile (Boeing)
- 1st launch successful on 24 Sep 1964 (Gibson 21)
- 1st silo launch achieved on 18 Aug 1965 (21)
- Designated the launching vehicle for emergency rocket communication satellites (22)
- President George H Bush ordered the deactivation of the Minuteman II force on 27 Sep 1991 (Polmar and Norris 172)

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W62 Minuteman III (LGM-30G) ICBM

LGM-30 (*Federation of American Scientists*)

General Specifications

- **Dimensions:** Length: 3 ft 3.3 in
  Diameter: 1 ft 7.75 in
  Weight: 253 lbs
  (Polmar and Norris 62)
- **Yield:** Kiloton class (62)
- **Inventory:** 1970 – current (62)
- **Weapons:** Minuteman III ICBM (62)

History of Warhead

- The W62 is the Lawrence Livermore Lab design for the MINUTEMAN III ICBM with the MK 12 RV. (Hansen 6:343)
- Development engineering started in June 1964. Production engineering of the W62 started in March 1967. Quantity production of the W62 started in March 1970 and continued through June 1976 and approximately 1,725 units were built (343)
- Retirement of early mods began in April 1980 (343-4)

National Museum of the US Air Force

General Specifications of Missile

- **Dimensions:** Length: 59 ft 8 in
  Diameter: 5 ft 6 in
  Weight: 77, 160 lbs
  (Polmar and Norris 173)
- **Inventory:** 29 Dec 1970 – current (173)
- **Range:** 8,000 – 9,000 miles (173)
- **CEP:** Approximately 600 ft (173)
- 3 stage solid propellant rocket (173)

History of Missile

- Between December 1979 and February 1983, W62s on MINUTEMAN III missiles were replaced by W78/MK 12A RVs, which have more fusing options, better CEPs, and more up-to-date penetration aids (Hansen 6: 344)
- W62s remained in the U.S. nuclear stockpile in mid-1991; some were scheduled for replacement by PEACEKEEPER/W87 weapons. The W62 is now completely retired and dismantled (344)
- Introduced multiple warheads to U.S. land-based strategic missiles (Polmar and Norris 173)
- 1st launch 16 Aug 1968
- Essentially same configuration as Minuteman II but with a new, enlarged third stage and warhead section (Gibson 22)

- Nation's first MIRVed missile capable of delivering 3 warheads against 3 separate targets (Gibson 22)

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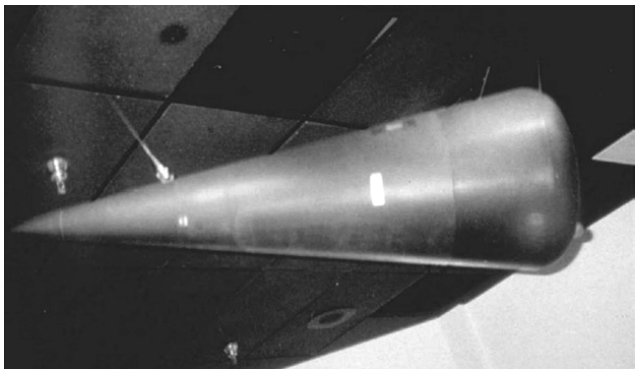
W78 MINUTEMAN III



Hansen 6:347

General Specifications

- **Dimensions:** Length: 5 ft 8 in
  Diameter: 1 ft 9.25 in
  Weight: approx 385 lbs
  (Polmar and Norris 66)
- **Yield:** Kiloton class (66)
- **Inventory:** 1979 – current (66)
- **Weapons:** Minuteman III ICBM (66)

History of Warhead

- The W78 is the warhead used in the Mark 12A MIRV for the Air Force's MINUTEMAN III ICBM (Hansen 6:345)
- Born in late 1969 or early 1970 with a request by DOD to the weapons labs to consider the feasibility of providing an ICBM re-entry vehicle warhead with a yield of 500 KT and a total weight of 400 lbs. Three of these would be MIRV'd on a MINUTEMAN III missile (345)
- Development engineering of the W78 began at Los Alamos in July 1974. The first production units were completed in August 1979 (345)
- LASL certified that the device would meet its requirements. Livermore did not agree, and went so far as to publicly challenge, in 1976, LASL claims with members of Congress and the Air Force. To settle the question, a special panel headed by former Livermore director John Foster was established to independently certify the yield of the W78. After a lengthy examination, the panel agreed with LASL's claims (346-7)
- Two or three warheads are carried in each RV, depending on desired missile range (347)

General Specifications of Missile

- **Dimensions:** Length: 59 ft 8 in
  Diameter: 5 ft 6 in
  Weight: 77, 160 lbs
  (Polmar and Norris 173)
- **Inventory:** 29 Dec 1970 – current (173)
- **Range:** 8,000 – 9,000 miles (173)
- **CEP:** Much greater than Minuteman II (173)
- 3 stage solid propellant rocket (173)

National Museum of the US Air Force

History of Missile

- CEP of the MINUTEMAN III was much better than the Minuteman II (Hansen 6: 347)

Sources

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W87 Peacekeeper (LGM-118A) ICBM

Figure 90 *Schematic of MK 21 RVs aboard an MX.*

Hansen 6:361

General Specifications

- **Dimensions:** Length: 5 ft 9 in
  Diameter: 1 ft 9 in
  Weight: 450 lbs
  (Polmar and Norris 69)
- **Yield:** Kiloton class (69)
- **Inventory:** 1986 – current (69)
- **Weapons:** Peacekeeper ICBM (69)
- The principle purpose behind developing the W87 was to reduce the use of special nuclear material (69)
-

History of Warhead

- The W87 was the Livermore-designed warhead for the MX/PEACEKEEPER ICBM (Norris) (Hansen 6:358)
- The W87 combined with the AVCO Systems Division Mark 21 re-entry vehicle provides a high-performance, hardened, enhanced safety weapon system with a high yield (Polmar) (358)
- W87s were deployed for use in 1986 (Norris) (359)
- The W87s have been retrofitted to the Minuteman III missiles due to the decommissioning of the MX/Peacekeepers. The first test launch for W87s in Minuteman IIIs was 13 November 1999 (Norris) (359)
- The W87 is contained in a cone-shaped housing within the MK 21 RV re-entry vehicle; the reentry vehicle is covered by a heat-shield to protect the warheads upon entering the atmosphere (National Museum of the U.S. Air Force) (360)
- The W87 warhead can be fused for five different air or surface burst options: high altitude burst, medium-altitude airburst, low-altitude airburst, surface proximity burst, and surface contact burst (360)
- One W87 was carried in each of 10 Mark 21 MIRVs per missile, which offered rapid pre-launch fusing and target selection (National Museum of the U.S. Air Force) (360)
- W87 warhead was also to be used for the MGM-134 Midgetman missile, which was a smaller ICBM developed to augment the Minuteman program. It was cancelled under the Bush, Sr. administration in 1992 (Yenne 71).

General Specifications of Missile

- **Dimensions:** Length: 71 ft
  Diameter: 7 ft 7 in
  Weight: 195,000 lbs
  (Polmar and Norris 176)
- **Inventory:** 22 Dec 1986 – 19 Sep 2005 (176)
- **Range:** 6,700 miles (176)
- 4 stage solid propellant rocket (176)

History of Missile

- First flight test 17 June 1983 (176)
- Start II, Peacekeeper missiles were retired, the last one on 19 Sep 2005 (176)

Sources

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SUMMARY OF ACCIDENTS INVOLVING NUCLEAR WEAPONS

B-36 / 13 February 1950

- A B-36 carrying a weapon with a dummy capsule was conducting a simulated combat profile mission from Eilson AFB, Alaska to Carswell AFB, Texas when it experienced serious mechanical difficulties (Narrative Summary)
- Pilots could not maintain level flight after the loss of three engines and released the weapon from 8,000 feet. Only the weapon's high explosive material detonated (Narrative Summary)
- The crew bailed out over Princess Royal Island. Twelve men were recovered out of the seventeen man crew. Eight others died from another plane crash during the rescue attempt (Vaughn)
- The aircraft wreckage was later found on Vancouver Island (Narrative Summary)

B-29 Accident / 11 April 1950

- A B-29 carrying a nuclear bomb crashed into a mountain on Manzano Base approximately three minutes after take-off, killing the entire crew (Narrative Summary)
- Detonators were installed in the bomb on board the aircraft. (Narrative Summary)
- The bomb case was destroyed and high explosive material burned in the gasoline fire. Other pieces of unburned high explosives were strewn throughout the wreckage. (Narrative Summary)
- No contamination or recovery problems occurred. Recovered components of the weapons were returned to the Atomic Energy Commission (Narrative Summary)
- The bomb was shattered but its nuclear capsule with the fissile materials (on board the aircraft) had not been inserted as a safety precaution. Because of this safety measure, a nuclear detonation was not possible (Narrative Summary)
- A merger in 1971 brought Kirtland, Manzano, and Sandia Bases together under one command, which today is Kirtland Air Force Base (Kirtland)

B-50 / 13 July 1950

- A B-50 on a training mission from Biggs AFB, Texas flew into the ground from 7,000 feet (Narrative Summary)
- Four officers and twelve airmen died in the crash (Narrative Summary)
- There was no nuclear capsule aboard, only the high explosive portion of the weapon detonated on impact (Narrative Summary)

B-2 / 5 August 1950

- B-29 carrying a weapon, but no capsule, was forced to attempt an emergency landing at what is now Travis AFB after two runaway propellers and landing gear retraction difficulties (Narrative Summary)
- Nineteen crew members and rescue personnel were killed in this incident (Narrative Summary)

B-50 / 10 November 1950

- Due to an in-flight emergency, a B-50 jettisoned a weapon containing no nuclear capsule from 10,500 feet over water. A high-explosive detonation followed.

B-47 / 10 March 1956

- A B-47 attempted a refueling procedure in poor visibility at 14,000 feet over the Mediterranean Sea (Narrative Summary)
- The aircraft never made contact with the tanker and the missing aircraft and crew were never discovered (Narrative Summary)
- Only two capsules of nuclear weapons material in carrying cases were aboard the aircraft and a nuclear detonation was not possible (Narrative Summary)

B-47 / 27 July 1956

- An unarmed B-47 flew out of control on take-off and crashed into a storage igloo for nuclear weapons (Narrative Summary)
- The bombs did not burn or detonate and there were no contamination/cleanup problems because the weapons were kept in storage configuration (Narrative Summary)

B-36 / 22 May 1957

- The B-36 was ferrying a weapon from Biggs AFB, Texas to Kirtland AFB (Narrative Summary)
- On approach to Kirtland, the weapon dropped from the aircraft. It was standard procedure to remove the locking pin of the release mechanism during takeoff and landing to allow for emergency jettison. It was during this procedure that the incident occurred (Narrative Summary)
- The high explosive material detonated, making a crater approximately 25 feet in diameter and 12 feet deep (Narrative Summary)
- No radioactivity was detected beyond the lip of the crater. There were no health or safety problems (Narrative Summary)

C-124 / 28 July 1957

- The C-124 carried three weapons and one nuclear capsule (Narrative Summary)
- Level flight could not be maintained after the C-124 lost power from its number one and two engines enroute from Dover AFB, Delaware (Narrative Summary)
- The crew decided to jettison two weapons. No detonation occurred. Both weapons are presumed to have been damaged from impact with the ocean surface and submerged almost instantly (Narrative Summary)
- Search for the weapons produced negative results (Narrative Summary)

B-47 / 11 October 1957

- Shortly after liftoff at Homestead AFB, one of the aircraft's outrigger tires exploded (Narrative Summary)
- The aircraft was carrying one weapon in the bomb bay and one nuclear capsule in the crew compartment (Narrative Summary)
- The weapon was enveloped in flames and burned for approximately four hours. Two low order high explosive detonations occurred during the burning (Narrative Summary)
- The nuclear capsule and its carrying case were recovered intact and only slightly damaged (Narrative Summary)
- All major components were accounted for (Narrative Summary)

B-47 / 31 January 1958

- The left rear wheel casting of the B-47 failed and its tail struck the runway on takeoff, rupturing the fuel tank. This event occurred at a base overseas (Narrative Summary)
- The aircraft burned for seven hours (Narrative Summary)
- The aircraft carried one weapon in strike configuration (Narrative Summary)
- High explosive weapon did not detonate, but there was some contamination in the immediate crash site (Narrative Summary)
- The wreckage and asphalt beneath it were removed to extract the contamination (Narrative Summary)

B-47 / 5 February 1958

- Near Savannah Georgia, the B-47 collided mid-air with a F-86. The damaged aircraft could not reduce its speed for a safe landing (Narrative Summary)
- The crew decided to jettison the weapon several miles from the mouth of the Savannah River. There was no nuclear capsule aboard the aircraft (Narrative Summary)
- No detonation occurred and the B-47 landed safely. The weapon was never recovered (Narrative Summary)

B-47 / 11 March 1958

- A B-47 accidentally jettisoned an unarmed nuclear weapon which impacted the earth in a sparsely populated area 6.5 miles east of Florence, South Caroline (Narrative Summary)
- The explosion caused property damage and several injuries. No capsule of nuclear materials was involved in this incident (Narrative Summary)

B-47 / 4 November 1958

- A B-47 caught fire on takeoff in Dyess AFB, Texas (Narrative Summary)
- Three crew members successfully ejected and one crewman died upon impact (Narrative Summary)
- The aircraft carried one nuclear weapon its detonation made a crater 35 feet in diameter and six feet deep (Narrative Summary)
- Nuclear materials were recovered near the crash site (Narrative Summary)

B-47 / 26 November 1958

- A B-47 caught fire on the ground at Chennault AFB, Louisiana (Narrative Summary)
- A single nuclear weapon on board was destroyed and contamination was limited to the immediate vicinity of the weapon residue within the wreckage (Narrative Summary)

F-100 / 18 January 1959

- An explosion and fire occurred when the aircraft's external fuel tanks inadvertently jettisoned at a Pacific base (Narrative Summary)
- The capsule was not in the vicinity of the aircraft (Narrative Summary)
- No contamination or cleanup problems after the fire was extinguished in seven minutes (Narrative Summary)

C-124 / 6 July 1959

- The aircraft crashed upon takeoff at Barksdale AFB, Louisiana and one weapon was destroyed in the resulting fire (Narrative Summary)
- No nuclear or high explosive detonation occurred (Narrative Summary)
- Limited contamination did not hamper rescue operations (Narrative Summary)

P-5M / 26 September 1959

- A U.S. Navy aircraft ditched in Puget Sound off of Whidbey Island, WA (Narrative Summary)
- It was carrying an unarmed nuclear anti-submarine weapon with no nuclear material (Narrative Summary)
- The weapon was not recovered (Narrative Summary)

B-52 and KC-135 / 15 October 1959

- The B-52 and KC-135 collided while refueling. The instructor pilot, pilot, electronic warfare officer, and radar navigator ejected from the B-52. The rest of the crew failed to leave the aircraft (Narrative Summary)
- The crewmembers of the KC-135 were fatally injured (Narrative Summary)
- The B-52's two unarmed nuclear weapons were recovered intact (Narrative Summary)

BOMARC / 7 June 1960

- A missile in ready storage condition at McGuire AFB, New Jersey was destroyed by explosion and fire after a helium tank exploded and ruptured the missile's fuel tanks (Narrative Summary)
- The warhead was destroyed but the high explosive did not detonate (Narrative Summary)
- Contamination was restricted (Narrative Summary)

B-52 / 24 January 1961

- The structural failure of the right wing of B-52 resulted in two weapons separating from the aircraft during aircraft breakup at 2,000-10,000 feet altitude. This incident occurred in Goldsboro, North Carolina (Narrative Summary)
- One bomb parachute deployed and received little damage. The other bomb broke apart upon impact, but no explosion occurred (Narrative Summary)
- 5 of 8 crew members survived (Narrative Summary)

B-52/ 14 March 1961

- The crew compartment pressurization system of the aircraft failed, forcing descent to 10,000 feet (Narrative Summary)
- Increased fuel consumption led to fuel exhaustion and the crew bailed out at 10,000 feet. The aircraft commander stayed with the aircraft to 4,000 feet to steer the plane away from populated regions (Narrative Summary)
- The two nuclear weapons were torn from the aircraft on impact. The high explosive did not detonate and there was no nuclear contamination (Narrative Summary)

Atomic Energy Commission Storage Igloo / 13 November 1963

- 123,000 pounds of high explosive nuclear weapons components exploded, causing minor injuries to three employees (Narrative Summary)
- Little contamination (Narrative Summary)

B-52 / 13 January 1964

- A B-52 D crashed 17 miles SW of Cumberland, Maryland due to severe turbulence that caused aircraft structural failure (Narrative Summary)
- Only the pilot and co-pilot survived (Narrative Summary)
- Both weapons remained in the aircraft and were relatively intact in the approximate center of the wreckage area (Narrative Summary)

LGM 30 B (Minuteman ICBM) / 5 December 1964

- The missile was on strategic alert at Launch Facility L-02 Ellsworth AFB, South Dakota (Narrative Summary)
- A retrorocket in the spacer below the reentry vehicle fired, causing the reentry vehicle to fall about 75 feet to the floor of the silo, receiving considerable damage (Narrative Summary)
- No detonation or radioactive contamination (Narrative Summary)

B-58 / 8 December 1964

- A B-52 slid off the side of the taxiway due to icy runway conditions (Narrative Summary)
- The left main landing gear struck a concrete electrical manhole box and the aircraft caught on fire (Narrative Summary)
- The crew escaped and contamination was limited to the immediate area of the crash (Narrative Summary)

C-124 / 11 October 1965

- A fire occurred during refueling (Narrative Summary)
- The aircraft's fuselage was destroyed by fire (Narrative Summary)
- No casualties and minor contamination (Narrative Summary)

A-4 / 5 December 1965

- The aircraft loaded with one nuclear weapon rolled off the elevator of a U.S. aircraft carrier into the sea (Narrative Summary)
- The pilot, aircraft and weapon were lost (Narrative Summary)

B-52 / 17 January 1966

- The B-52 and KC-135 collided during refueling (Narrative Summary)
- Both aircraft crashed near Palomares, Spain (Narrative Summary)
- Four of the eleven crew members survived (Narrative Summary)
- Four nuclear weapons were aboard the aircraft. One was recovered on the ground and one recovered from sea. (Narrative Summary)
- Approximately 1400 tons of slightly contaminated soil and vegetation were removed to the United States for storage at an approved site (Narrative Summary)

B-52 / 21 January 1968

- A B-52 crashed and burned some seven miles southwest of the runway at Thule AB, Greenland while approaching the base to land (Narrative Summary)
- Six of seven crewmembers survived (Narrative Summary)
- All four nuclear weapons aboard were destroyed by fire (Narrative Summary)
- Approximately 247,000 cubic feet of contaminated ice, snow and water, and crash debris were removed to an approved storage site in the United States (Narrative Summary)

Spring 1968 at Sea

- Details remain classified (Narrative Summary)

Titan II ICBM / 19 September 1980

- During routine maintenance, a repairman dropped a heavy wrench socket, which rolled off a work platform and fell toward the bottom of the silo (Narrative Summary)
- The socket struck the missile and caused a leak from the pressurized fuel tank (Narrative Summary)
- The complex was evacuated (Narrative Summary)
- After 8.5 hours, the silo exploded and killed one and injured twenty one others (Narrative Summary)
- The nuclear warhead was recovered intact (Narrative Summary)

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FOREIGN MISSILE HALLWAY

*All models in this hall are 1/10 scale (a 6' person would be 7.2" in 1/10 scale)

Foreign Missile Hallway of the Cold War Era

These are representative missiles (**1/10 scale**) from Russia (Former Soviet Union), China and France that were deployed during the Cold War. Some of these missiles are now retired. Placards in front of the weapons use North Atlantic Treaty Organization (NATO) designations for each of the weapons systems … specifically for RUSSIA (Former Soviet Union) with brief descriptions of their general capabilities. Designations were used primarily for communication brevity with ourselves and allies.

Notice the NATO designations for the RUSSIAN Missiles … you will see SS-2 thru SS-25 and a name associated with it with always the first letter starting with an "S". This designation indicates that it is a Surface to Surface weapon. If you see for example SS-N-18 this means that it is a weapon system designed to launch from a naval ship or submarine. If you notice an X anywhere in the designation this refers to the missile as being an "experimental" type missile.

France

- Why are the French missiles smaller than the other missiles in this hallway?
    - Range - France only needed missiles capable of crossing Europe during the Cold War to offset the Soviet Union.
- In 1996 the nuclear Force de Frappe (Strike Force) of France went from a triad to a dyad of only sub and air launched nuclear weapons and all missile silos were deactivated (Table of French Nuclear Forces, 2002).
- In 2008 French President Nicolas Sarkozy reduced the French stockpile to 300 warheads (third largest worldwide) (Norris and Kristensen 78, 80).
- Nuclear weapons program so heavily emphasized by Charles de Gaulle as a way to become militarily independent of the United States. Eventually led to France's withdrawal from NATO (Palmowski).

French Missiles

M-4 Submarine Launched Ballistic Missile (SLBM)

- Deployed 1985 (Epstein 57)
- 6x150 Kt Yield MIRV (57)
- 3 Stage Solid Fuel (France Nuclear Forces: M-4 / M-45)
- Range 4,000-6,000 km (Epstein 57)
- The M-45 was an improved version of the M-4 that was deployed in 1997 (France Nuclear Forces: M-4 / M-45)

S-3 Intermediate Range Ballistic Missile (IRBM)

- Deployed 1980-1996 (France Nuclear Forces: S-3)
- 1.2 Mt Yield warhead (S-3)
- 2 Stage Solid Fuel (S-3)
- Range 3,500 km (S-3)

Pluton Short Range Ballistic Missile (SRBM) Road Mobile

- Deployed 1974 (Epstein 57)
- HE or 20/25 Kt warhead (57)
- 1 Stage Solid Fuel (France Nuclear Forces: Pluton)
- Range 120 km (Epstein 57)

Sources

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China

- China's nuclear program started in 1955 when Mao Zedong initiated it with deported U.S. nuclear weapons expert Qian Xuesen in charge (China's Nuclear Force 52-53).
- China has smaller and larger missiles represented in this hallway which shows their deterrence is aimed at what they perceive as both regional and global threats, such as missiles with a range just inside Japan, the Philippines, Guam, and the United States (53).
- China has a growing nuclear force but it does not appear that it will invest the massive amount of resources that the U.S. and U.S.S.R. invested in their nuclear forces during the Cold War, instead China appears focused on a small but effective modernized force (fourth largest worldwide).
- NATO designation; CSS (China Surface to Surface), Chinese nomenclature is Dong Feng (DF) or East Wind.
- The first Dong Feng (DF-1) was a copy of the Soviet R-2 missile, which was based on the German V-2 technology (53)

Chinese Missiles

CSS-1/DF-2 Intermediate Range Ballistic Missile (IRBM)

- Deployed 1966 (Chang 222)
- 15-20 Kt warhead
- 1 Stage Liquid Fuel
- Range 1,050 km, greater for DF-2A (222)
- Made from reverse engineered technology from Russian IRBMs given to China in the late 1950s (Bennett 193)

CSS-2/DF-3A Intermediate Range Ballistic Missile (IRBM)

- Deployed 1971
- HE or 1-3+ Mt warhead (Bennett 194)
- Single Stage Liquid Fueled Missile (Cox 181)
- Range 2,650/2,800 km (Bennett 194)
- 40-60 in inventory in 1999, retired and replaced by the CSS-5 by 2010 (Bennett 193-4)
- CEP of 1-2 km (194)

CSS-3/DF-4 Intermediate Range Ballistic Missile (IRBM)

- Deployed 1981
- 2 Mt warhead (Bennett 194)
- Two Stage Liquid Fueled Missile (Cox 180)
- Range 4,750-5500+ km (Bennett 194)
- 20-35 in inventory in 1999, retired and replaced by the CSS-9 by 2010 (193-4)
- CEP of 1.5 km (194)

CSS-4/DF-5A Intercontinental Ballistic Missile (ICBM)

- Deployed 1981 (China's Nuclear Force 56)
- 4-5 Mt warhead (Bennett 194)
- Two Stage Liquid Fueled Missile (Cox 180)
- Range 11,000-13,000 km (Bennett 194)
- Some left in the inventory in 2010, but mostly replaced by the CSS-10 (193-4)
- CEP of 0.5-0.8 km (194)
- First Chinese missile capable of hitting most of the continental United States (Cox 180).

CSS-5/DF-21 Intermediate Range Ballistic Missile (IRBM) Road Mobile

- Deployed 1988
- Land-based version of the CSS-N-3 (DeGraffenreid 188-9)
- HE or 250 Kt warhead (Bennett 194)
- Solid Fueled Missile (Cox 180)
- Range 1,800-2,500 km (Bennett 194)
- 80-120 in inventory in 2010 (194)
- DF-21 Mod 4 is land based version of CSS-N-3/JL-1 Submarine Launched Ballistic Missile (SLBM)
- CEP of 0.7 km, but they are working to reduce it to 50 m (Bennett 193)
- Built to replace the CSS-2 (193)

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Russia/ Former Soviet Union

- "Soviet and American responses to the nuclear revolution were quite different, shaped by contrasting military cultures." The Red Army dominated the Soviet Armed Forces and made the Soviets a traditional continental power. Both the Soviet air force and navy answered to the army (Zaloga 2)
- The U.S. was a global maritime power, and the U.S. Air Force also adopted this global reach policy. "The institutional culture of the U.S. armed forces was already aligned to the notion of long-range power projection. In contrast, the Red Army lacked such traditions, and it had to be initiated from the top" (3)
- Soviet research on nuclear weapons before WWII was on a small scale and did not have strong government backing. "The outbreak of war in June 1941 put an end to the early Soviet nuclear program, because the staff was diverted for more pressing needs" (5)
- "The new catalyst for the program came from the extensive Soviet espionage network. On 4 November 1941, Laurenty Beria, the head of Soviet NKVD secret police, received a coded telegram from the London embassy indicating that theoretical work on a uranium bomb was being undertaken in England" (5)
- Stalin ordered the start of the Soviet atomic bomb program in May 1942 (6)
- The Soviet bomb program was headed by a young physicist named Igor Kurchatov. Resources were scarce. "Kurchatov later stated that the work of the espionage agencies accounted for half the success of the Soviet atomic bomb program." (6) "A Russian scientist involved in the bomb program later concluded that German aid in the form of the captured scientists, uranium, and laboratory equipment accelerated the Soviet bomb program by as much as five years" (7)
- "The first test of the RDS-1 bomb was conducted on 29 August 1949 and had a yield of about twenty-two kilotons" (10)
- NATO Acronyms used in this hallway; Surface to Surface (SS), Surface to Surface Naval (SS-N) and experimental (X) weapons which were not fielded (two in this hallway)
- Russian acronyms begin with R
- NATO Designations are not the actual names and all begin with the letter S

Sputnik and the Space Race

- On October 4, 1957 the USSR launched Sputnik I, the world's first artificial satellite. It followed in November with Sputnik II ("Sputnik")
- Sputnik started the space race between the United States and the USSR ("Sputnik")
- The United States launched its own satellite, Explorer I, on January 31, 1958 and created NASA on October 1, 1958 ("Sputnik")
- The Space Race was a critical theater in the Cold War ("Space Race")
- Two aspects to the Space Race
    - Military: Nuclear warheads needed missile and rocket carriers. Satellites could provide crucial information ("Space Race")
    - National Prestige: As demonstrated by the race to the moon ("Space Race")

INF Treaty

- Signed 8 December 1987 and went into effect on 1 June 1988 (INF 1)
- Set a precedent for START I (1)
- The treaty obligates the United States and members of the Soviet Socialist Republics to eliminate their shorter-range missiles, missile launchers, and all other specified support equipment for these weapon systems within 18 months after the treaty comes into effect (1)
- US Missiles Affected: Pershing II, Pershing IA, BGM-109 G (1)
- Soviet Missiles Affected: SS-20, SS-4, SS-5, SS-12, SS-23 (1)
- Also banned production and flight testing of intermediate and shorter range missiles (2)
- Specified types of inspections to facilitate accountability in this process (3)

START I and II and New START (Strategic Arms Reduction Treaty)

- SNDVs (Strategic Nuclear Deployment Vehicles) reduced to 1600
- Launchers of eliminated missiles were destroyed
- Warhead cap set at 6000 total nuclear warheads
- All treaty requirements were met prior to the 2001 deadline
- In order to confirm compliance with the treaty, 659 inspections were conducted on the United States and 481 were conducted on Russia
- Treaty signed 5 December 1994, and expired 15 years later on 5 December 2009
- New START was signed and approved 26 January 2011
- New START further reduces nuclear weapons, from 880 launchers and 2152 warheads in 2010 to 792 launchers and 1550 warheads by 2017 (New START)

Russian Missiles

SS-2/R-2 Sibling Short Range Ballistic Missile (SRBM)

- Deployed 1953 (Zaloga 38)
- HE warhead (38)
- 1 Stage Liquid
- Range 600 km (Soviet Nuclear Weapons 7)
- An improved version of the German V2 with a separating warhead, 1545 R-1 & R-2 missiles produced. (Zaloga 39)
- This design was given to the Chinese and produced as the DF-1 and formed the foundation of the Chinese missile program (China’s Nuclear Force 53)

SS-4/R-12 Sandal Intermediate Range Ballistic Missile (IRBM)

- Deployed 1959, Retired 1989 (Zaloga 238)
- 1-1.3 Mt warhead (238)
- 1 Stage Liquid
- Range 2080 km (238)

- This missile was at the heart of the Cuban Missile Crisis when the USSR attempted to secretly base them in Cuba (83)
- There were a maximum of 608 launchers in the 1960s, but the last of the R-12s were retired in compliance with the Intermediate range Nuclear Forces Treaty (INF) (Podvig and Bukharin 186).
- Design was possibly sold to the Iranians in 1998 for their Shabad 4 IRBM program (Encyclopedia Astronautica)

SS-5 SKEAN (R-14)

- Entered service in the early 1960s (Podvig 3)
- Range of 2200 nautical miles with a CEP of 2 miles (The "Milk Run" 19)
- Each weapon contained a 3-5 megaton warhead (19)
- Missiles were single stage, liquid fueled, and equipped with one warhead (Federation of American Scientists R-14)
- Dispatched to Cuba in 1962 (The "Milk Run" 5)
- Four launching sites were being built in Cuba at the time of the Cuban Missile Crisis. Each site could accommodate eight missiles (19)
- SS-5 ICBM's never made it to Cuba (19)
- In cooperation with the INF Treaty, the Soviet Union eliminated all SS-5 missiles in 1988 (Podvig 21)

SS-7 SADDLER (R-16)

- Commissioned on 20 October 1961 (Podvig 189)
- Two stage missile equipped with a single warhead (189)
- Megaton Yield (190)
- Range of 11,000-13,000 km (190)
- CEP of 2.7 km (190)
- It was the first ICBM with storable liquid fuel (190)

SS-11 SEGO (UR-100)

- Commissioned 21 July 1967 (Podvig 204)
- Two stage single warhead missile (201)
- Liquid Fuel (UDMH) (202)
- 1.1-1.3 Megaton Yield (202)
- Max Range 11,000 km (202)
- CEP of 1.4 km (203)
- Could only be used against soft, unprotected targets (203)
- 1st Missile to be used with a sealed transport and launch container (TPK) (203)
- Main ICBM adopted for use by the RVSN (204)

SS-18 SATAN (R-36M)

- "The development of the new heavy R-36M (SS-18) ICBM was not particularly controversial, and it was viewed as simply an evolutionary extension of the earlier R-36 (SS-9)" (Zaloga 148)
- "The role of the new missile was viewed as a versatile system that could be used in a counterforce role when armed with an accurate single warhead, and a counter value weapon against cities or non-hardened military targets such as air bases when armed with a MIRV warhead" (149)
- "The initial version of the R-36M (SS-18 Mod 1) was armed with a single 24-megaton nuclear warhead. This was followed by development of the heavy MIRV, armed with eight 600-kiloton warheads"(149)

SS-19 STILLETO (UR-100N)

- This missile was an improvement on the UR-100 (SS-100) missile, but it was almost double the weight and three times the payload (Zaloga 148)
- The system was accepted for service on 30 December 1975 (148)
- The missile often oscillated prior to first-stage burnout, which caused accuracy problems (148) Because of this problem, there was a sudden withdrawal of all UR-100N missiles by 1983, which was prior to its guaranteed shelf life of ten years (148)

SS-24 SCALPEL (RT-23)

- ICBM that launches with 10 MIRV warheads, this missile is a 3 stage solid fuelled missile that can deploy from either a silo or rail based system.
- All models of this missile have inertial guidance systems and an onboard digital computer.
- Each of the 10 warheads has a maximum yield of 550 Kt. The range is between 10,000-11,000 km. The CEP is anywhere between 150-500 m (Federation of American Scientists "RT-23 / SS-24 SCALPEL").
- Although all of these missiles were supposed to be eliminated by 2007 under the START II, Russia was allowed to keep 36 of them after negotiation (Hildreth 11).

SS-25 SICKLE (RS-12M)

- 3 stage solid fuelled missile designed for use with the Topol road-mobile launcher (Spassky 96)
- It is an improved version of the RS-12 ICBM (96)
- It has one reentry vehicle and a guidance/control system, which gives the system a very high accuracy (96)
- The unique feature about this system was how mobile it was; the command and control centers and launch system moved with the missile (97)
- The entire system entered service in 1988 (97)
- The range of the missile is 10,500 km, the CEP is between 150-900 m, the yield is 550 Kt (Federation of American Scientists "RT-2PM - SS-25 SICKLE")

SS-9 SCARP (R-36)

- 2 stage liquid fuelled missile equipped with a single warhead with heavy reentry vehicles and a decoy dispenser (Spassky 71)
- Inertial guidance/control system that also had gyro-stabilized platform and a digital computer (71)
- Had a CEP of 1200 m, and entered service in 1967 with single launch silo launchers (71)
- The R-36orb (orbital missile introduced in 1968) and the R-36P (MIRV warhead version) were based off of the original SS-9 (72)
- The R-36 had a range of 15,500 km, while the R-36orb had a max range of 40,000 km. The max yield for the heavy warhead was 10 Mt (72)

SS-12 SCALEBOARD (TR-1)

- Single stage, liquid fueled rocket that uses the same chassis as the Scud-B, but it was sealed in an environmental container
- It was similar to the Scud-B as well, except it had an improved range, accuracy, and a larger warhead.
- In service in the mid-1960s, it was replaced by the SS-22, also known as the SS-12B, starting in 1979
- This version was much more accurate, with a CEP of 0.37 km
- The range was a max of 900 km, and the warhead was 500 kt
- Due to the INF Treaty, the last of the SS-12 missiles was decommissioned 25 July 1989 (Federation of American Scientists “TR-1 SS-12”)

SS-X-10 SCRAG (UR-200)

- The UR-200, developed by Chelomey, was the rival missile in competition with the R-36 (SS-9), developed by Yangel (Zaloga 110)
- “The general configuration of the UR-200 was similar to that of the R-36 and also started out using a hybrid radio-inertial guidance system” (110)
- The missile was plagued by flight-control problems during its beginning phases in 1963 (110)
- In October 1964 Nikita Khrushchev decided to select the R-36 design over the rival Chelomey UR-200 design for the new ICBM requirement. The R-36 offered greater throw weight, and both its engine design and missile construction techniques were considerably more mature than the Chelomey design (111)

SS-13 SAVAGE (RS-12)

- Entered service in 1968 and was a three stage solid fuelled single warhead missile (Spassky 73).
- Launched from a single-launch silo (73)
- An improved version was released in 1972, which improved the range from 10,200 km to 10,600 km (74)
- The yield of the single warhead in both versions was 750 Kt, and the CEP was 4 km in the early version and 3.2 km in the modernized version (74)
- It was equipped with a decoy warhead to help penetrate enemy missile defense systems (73)

- In 1995 all of these missiles were dismantled under the SALT II treaty (74)

SS-N-23 SKIFF (R-29RM)

- Carried by Project 667BDRM submarine, and entered service in 1986 (Spassky 203)
- 3 stage liquid fuelled missile with MIRV deployment system (203)
- The third stage and warhead propulsion motors were a single assembly that was fed from one fuel source (203)
- Used very accurate stellar-inertial guidance system, flight trajectory correction using satellite radio links, and could be fired over Arctic latitudes (204)
- Could carry up to 10 warheads, but after SALT-1 they only carried 4 (204)
- 8300 km range, CEP of .5-.6 km, Yield of warheads was 100 kt per vehicle (Zaloga 239)

SS-N-20 STURGEON (R-39)

- Carried by Project 941 submarine, entered service in 1983 (Spassky 198)
- Soviet Navy's first 3 stage solid propellant intercontinental ballistic missile (198)
- The reentry vehicles have liquid fuel for targeting and propulsion (199)
- Used a rail-based system for loading and unloading the missile onto the submarine instead of cranes. Also held in suspension onboard in case of emergency dives. (199)
- MIRV deployment system with 100 Kt in each vehicle (4-10 total). 8300 km max range, 1.4 km CEP (Zaloga 239)

SS-N-18 STINGRAY (R-29 SLBM)

- Entered service in 1974, and carried by the 667B and 667BD submarines (Spassky 190)
- World's first two stage, liquid fuelled intercontinental submarine launched ballistic missile, and it featured integral fuel tanks (190)
- Had celestial azimuth correction of flight trajectory, digital computing systems, and had rubberized metal shock absorbers (191)
- Max yield 45 kt, max range 8000 km (Federation of American "R-29R/R-2S")

SS-21 SCARAB

- Fired from the 9P129 6x6 vehicle
- The improved version has a maximum range was 120 km, CEP of 160 m, can carry submunitions, high explosives, nuclear weapons, chemical, terminally guided, and smart-munition bomblet warheads
- Much more mobile than the FROG-7 system (Federation of American Scientists "SS-21 SCARAB")
- These missiles were used in the Georgian-Russian conflict in 2008 and in the Chechnya conflict at the turn of the millennium (Felgengauer)

FROG 3 (R9)

- First successful launch on 21 April 1961 (Zaloga 68)
- After many failed launch tests, the R9A was finally accepted for service on 21 July 1965 (70)
- Equipped with complicated high-speed pumps (70)
- Along with the R-16, considered to be the first generation of Soviet ICBMs (70)
- U.S. intelligence assessed the R-9A as having only a 55 percent force reliability due to its complicated fueling system. It first took the Soviets sixteen hours to prepare and fuel the R-9, move it to the launcher only to wait another twenty-one minutes from that point until launch (88-9)

FROG 7 (Free Rocket Over Ground)

- Stands for "Free Rocket Over Ground," unguided, spin-stabilized, short range artillery rockets
- Single stage, range of 70 km, 550 kg warhead, capable of high explosive, chemical, or nuclear warheads
- The FROG-7A replaced the earlier FROG versions, and was deployed 1965
- The FROG-7B was released 1968, and eventually replaced by the improved SS-21 in 1976
- Cuba, Egypt, Iraq, Kuwait, Libya, North Korea, Syria, and Yemen all acquired FROG-7s (Federation of American Scientists "FROG-7A")

SS-1B Scud A (R-11)

- First ballistic missile with a launch weight of 54 tons. Could be kept on the launcher for extended periods of time due to use of high-temperature propellants (nitric acid and kerosene) (Spassky 54)
- Developed from German V2 technology, but instead of cryogenic fuel source, it used a red-fuming nitric acid/kerosene mixture that was highly corrosive against hydrocarbons, like human flesh. The head Soviet scientist Sergei Korolev called the fuel mixture "the devil's venom." (Zaloga et al. 4-5)
- Average CEP of 1.19 km, and the design was a much more simplified version of its V2 predecessor (5)
- 13 July 1955 the R-11 (SS-1B Scud A) entered Russian service as a high explosive delivery missile, though the nuclear version was added shortly afterwards (5)
- The nuclear-carrying version of this missile, the R-11M, was deployed for service 1 April 1958 after a testing period, including one test flight with a live nuclear device (7)
- Saddam Hussein used Scud missiles to attack coalition forces during the Gulf War (Back Cover)

SS-1C Scud B (R-17E or R-300E)

- First operational 1967 with a max range of 300 km with normal conventional payload (Cordesman 33)
- CEP is about 1000 m, and Russian versions can be equipped with high explosive, fuel-air explosive, runway penetrator, submunition, chemical, or nuclear warheads (33)
- The export version comes with a high explosive warhead weighing about 1000 kg (33)
- The Scud B impacts its target at a speed of over 1.5 Mach (34)
- Iran has acquired anywhere from 200-300 Scud Bs, mostly from North Korea, and it is believed they now have the capability to produce all variants on their own (34)
- Iran and Iraq used Scud missiles in 1988 in the "War of the Cities" (34)

- Scuds used as recently as August 2011 when Gadaffi fired a Scud missile against rebel forces during the Libyan uprising (McElroy)

SS-16 SINNER (RT-21)

- First Russian attempt at developing a mobile ICBM, it was a 3 stage solid-fuelled missile intended for silo and mobile deployment
- Range of 9200-10,500 km, an optimal CEP of 360 m, and a single warhead with a yield between .65-1.5 Mt
- Although never officially deployed, reports speculate that it entered Russian service around 1978
- Whether or not they had actually been deployed, the INF Treaty removed all supporting equipment for the SS-16 in 1985 and all of the missiles should have been decommissioned (Federation of American Scientists "RT-21 / SS-16 SINNER")

SS-17 Spanker (MR UR-100)

- Created to replace the light UR-100 ICBM (Podvig 212)
- Two stage single warhead missile (213)
- Storable liquid fuel (UDMH) (212)
- Max Range 10,320 km (213)
- CEP of no more than 1080 m (213)
- Commissioned on 17 December 1980 (214)

SS-20 SABER (Pioneer) Missile

- "The Pioneer was essentially the first two stages of the Temp-2S ICBM, but with a new postboost vehicle. Like the Temp-2S, it could be armed with MIRVs, carrying three warheads" (Zaloga 171)
- The Pioneer system was accepted for service on 11 March 1976 (171)
- "While the Pioneer could not remove the Tomahawk threat, some Soviet leaders saw it as a response." (173)
- As part of the INF Treaty, signed 1 June 1988, the Soviets agreed to eliminate all Pioneer missile systems (Podvig 21)

SS-N-5 SARK (R-21)

- Deployed in 1963 till the late 1980s, this missile was carried by the Projects 629A and 658M submarines (Spassky 180)
- First Soviet SLBM designed to be launched from submerged submarines (180)
- One stage liquid fuelled missile (180)
- The entire missile was sealed to prevent water from compromising its systems (180)
- Launcher featured lever-action and spring-type shock absorbers (180)
- Maximum yield between 1-3.5 Mt. Range 1400 km. 1800-3900 m CEP (Federation of American Scientists "R-21 / SS-N-5 SARK")

SS-N-08 SAWFLY (R-29)

- "The R-29 (SS-N-08) was a two stage design with an effective range of 5,000 miles, compared to only 1,500 miles for the older R-27 (SS-N-6)" (Zaloga 156)
- The R-29 had a novel stellar navigation feature for improved accuracy (156)
- The R-29 was the first Soviet SLBM (Sea-launched ballistic missile) to use lightweight decoys to penetrate U.S. ABM defenses (156)
- The first test launch occurred on 25 December 1971 (156)

SS-N-17 SNIPE (R-31)

- The R-31 SLBM was the Navy's first two-stage solid-propellant missile (Spassky 187)
- Designed to destroy strategic targets (187)

SS-N-6 SERB Mod 1 and SS-N-6 SERB Mod 3 (R-27 and R-27U)

- Medium-range strategic missiles deployed in 1968; carried by Project 676A and 667AU submarines (Spassky 185)
- Single-stage liquid fuelled rocket that was manufacturer-sealed with the propellant already inside. This greatly cut down on the preparation time (185)
    - Launch preparation time was 10 minutes, with 8 seconds between launches (186)
- Single warhead for the R-27; the R-27U, which was released in 1974, had MIRV capability (185-186)
- The R-27 had a range of 2500 km, the R-27U had a boosted range of 3000 km when it carried the original single warhead, and it featured greater accuracy (15% increase) than its predecessor (186)

SS-N-X-13 (R-27K)

- Navy version of the R-27 designed to destroy naval targets; developed at the same time but had much less emphasis (Zaloga 117).
- The navy wanted this missile because they did not trust shore-based naval missiles, but even though the Project 667V submarine would have easily been able to carry the system, the SALT I treaty counted these missiles against the Soviets' strategic missile limit. As a result, the R-27K was transferred as an experimental missile in 1974 (117-118).

SS-N-1 SCRUBBER (P-1)

- 1st surface to surface missile to be deployed by the Soviet Navy in 1959 (Polmar 392)
- Max Range of approximately 100 nautical miles (392)
- Awkward to handle and withdrawn in the late 1960s (392)

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LEON SMITH ROOM INFORMATION

Origin of the U.S. Nuclear Weapons Program

- 1919. Ernest Rutherford artificially transmutes nitrogen to oxygen at Cambridge University. High energy particles with a positive charge were given off; Rutherford discovers the existence of protons (Gosling 1).
- 1932. James Chadwick discovers the neutron, which explains the existence of isotopes (Gosling 1).
- 1932. J.D. Cockroft and E.T.S. Walton split the first atom by bombarding lithium with protons from a particle accelerator, which split the lithium into two helium nuclei (Gosling 1).
- 1932. Ernest O. Lawrence, M. Stanley Livingstone, and Milton White operate the first cyclotron at the University of California at Berkeley (Gosling 1).
- 1934. Italian scientist Enrico Fermi develops neutron bombardment, which allows the fired neutron to pass without resistance through the nucleus. This disproves the commonly held thought that harnessing nuclear power is improbable (Gosling 2).
- 1938. Otto Hahn and Fritz Straussmann bombard uranium with neutrons and notice that it breaks into pieces of radioactive barium and uranium. These also weighed less as a whole than the original piece of uranium at the beginning of the experiment, validating Einstein's equation of $E= mc^2$ (Gosling 2).
- 1938. Lise Meitner and Otto Frisch make calculations based on the Hahn-Straussman experiment to prove that fission was occurring. Meitner comes up with the name "fission" from the biological cell division term "binary fission" (Gosling 2).
- Early 1939. Meitner and Frisch give their findings to America-bound Niels Bohr. Bohr validates their findings en route on 16 January 1939. On 26 January, along with Enrico Fermi, Bohr presents these findings at a conference in Washington, D.C. to the American scientific community, which included many European scientists who fled from Nazi Germany (Gosling 3).
- August 1939. Albert Einstein, with heavy influence from Hungarian physicist Leo Szilard, writes a letter to President Roosevelt imploring American research into atomic weapons before Nazi Germany. 11 October 1939. Roosevelt sets up a committee to pursue nuclear research for military purposes (Gosling vii).
- March 1940. John R. Dunning proves that uranium-235 fissions with slow moving neutrons, which meant that it was the isotope that could be used in a chain reaction situation. This leads to uranium-235 being used in the atomic bomb (Gosling 4).

The Manhattan Project

- 19 January 1942. President Roosevelt approves the pursuit of an atomic bomb, and the Manhattan Project is born (Gosling 10).
- The initial funding for the Manhattan Project was $6,000 (Loeber 10).
- March 1942. The Army Corps of Engineers becomes involved in the Manhattan Project and quickly takes control of a majority of the administrative side of the project (Gosling 12).
- 17 September 1942. Colonel (less than a week later promoted to Brigadier General) Leslie Groves takes command of the Manhattan Project. He restructures the project and makes much progress. Also moves headquarters from New York to Washington (Gosling 13).
- General Groves was known for his work in building the Pentagon, as well as his strong leadership and organization skills, before heading the Manhattan Project (Gosling 13).
- J. Robert Oppenheimer and his team of "luminaries" work on the theoretical side of the Manhattan Project while the logistical and production details are assembled. After some experiments, Oppenheimer determines that even more uranium is needed for the bomb (Gosling 15).

- 2 December 1942. “Enrico Fermi achieved the first self-sustaining nuclear chain reaction in a ‘pile’ experiment under the stands of Stagg Field at the University of Chicago.” His pile was a massive work of 400 tons of graphite, six tons of uranium metal, and fifty tons of uranium oxide. This proved that Pu-239 could be produced in a nuclear reactor (Loeber 22).
- 28 December 1942. President Roosevelt makes the final decisions on uranium-235 and plutonium procurement. DuPont agrees to lend its industrial support, and ultimately invests two billion dollars in the Manhattan Project (Gosling 16).
- Manhattan Project had three main centers: Oak Ridge, Tennessee; Hanford, Washington; Los Alamos, New Mexico.
- Oak Ridge: comprised of Y-12 area, X-10 area, and K-25 area.
    - Y-12: Electromagnetic plant used for uranium enrichment
    - X-10: plutonium pile and separation facilities, less important after the development of the piles at Hanford
    - K-25: gaseous diffusion production of fissionable materials (Gosling 20).
- The Y-12 plant in Oak Ridge provided all of the enriched uranium needed for the first atomic bomb (Loeber 21).
- By the end of WWII, Oak Ridge was consuming 1/7th (14.3%) of the power generated in the United States (Gosling 20).
- Los Alamos: called Project Y, this laboratory was selected by Oppenheimer and approved by General Groves for its isolation (Gosling 35). Oppenheimer owned a home near Sante Fe and had discovered the Los Alamos area years earlier while on a pack trip (Loeber 21). Much of the bomb design and theoretical concepts were developed at Los Alamos, and it remained mostly an academic community of scientists from around the country (Gosling 37).
- Hanford: The DuPont headquarters, codenamed Site W. Hanford was chosen for its isolation and readily available hydroelectric power. This was the primary production center for plutonium (Gosling 28). They used a water-cooled, pile approach developed by Met Lab for plutonium production (Gosling 30).

Trinity Test

- Codenamed “Gadget,” the bomb used at the Trinity test site was a plutonium bomb similar to Fat Man.
- At 0530 on Monday, 16 July 1945, Gadget was detonated from a 100 foot high tower. This was the beginning of the atomic age of warfare.
- It released 18.6 kilotons of destructive power near the town of Alamogordo, New Mexico (Gosling 48).

Hiroshima

- President Truman gave the order to bomb the city of Hiroshima as early as 1 August, but weather delayed the mission date to 6 August.
- The 509th Composite Group was placed in charge of executing the mission.
- The B-29 Enola Gay, piloted by Colonel Paul Tibbets, was the bomber that held the uranium bomb known as Little Boy. It was accompanied by escort planes carrying observation and photography equipment.
- The Enola Gay took off from Tinian Island, which was 1,500 miles away from Hiroshima.
- At 0815, the 9,700 pound atomic bomb was dropped out of the Enola Gay from 31,000 feet. Forty-three seconds later it detonated at an altitude of 1900 feet above the city.
- The initial death toll was 70,000, but by the end of the year it rose to 140,000. Five years later the death toll had risen to 200,000 due to radiation sickness.
- 5 square miles of the city were completely destroyed.

- Little Boy, with a yield of approximately 15 kilotons, actually caused more damage than Fat Man, which had a yield of approximately 21 kilotons. The smaller yield killed more people because of the firestorm generated by the bomb at Hiroshima, and because the hills surrounding Nagasaki protected parts of the city from Fat Man's blast (Polmar and Norris 37).
- Truman warned that if Japan did not surrender, more of these atomic weapons would be used. (Gosling 51).

Nagasaki

- Because Japan failed to produce an official surrender, the U.S. pressed forward with its plan to use yet another nuclear weapon. The initial plan was to use the bomb known as Fat Man on 11 August, but impending bad weather forced the mission to be moved up to 9 August.
- The B-29 named Bock's Car took off from Tinian Island at 0347 and flew to its primary target of Kokura Arsenal. However, heavy flak combined with poor weather made it unfavorable to drop the bomb, and the secondary target of Nagasaki was selected.
- Coincidentally, Nagasaki was the location of the Mitsubishi plant that produced the torpedoes used by the Japanese at Pearl Harbor.
- At 29,000 feet, the 10,000 pound plutonium bomb was dropped at 1101. It then exploded at 1650 feet above the city (Gosling 53).
- Initially 40,000 people were killed and 60,000 were injured. However, the total death toll rose to 140,000 due to the effects of radiation.
- Three square miles of the city were destroyed, mostly because the hills surrounding the city shielded many buildings from the blast.
- Japan surrendered shortly after the bomb on Nagasaki was dropped (Gosling 54).

Operation Crossroads

- In July of 1946 the Manhattan Project tested two more plutonium bombs on empty ships in front of spectators in the Pacific Ocean, near the Bikini Atoll (Gosling 55).
- The Navy was very interested in atomic weapons after WWII and wanted to determine the effects of atomic bombs on naval ships. The Navy requested an aerial drop and two undersea drops (Polmar and Norris 38).
- During test Able, 1 July 1946, the B-29 *Dave's Dream* dropped a Mk 3 bomb that detonated 520 feet above the target ships. The target was the abandoned battleship *Nevada*, but the bomb missed by 2,130 feet. The 21-kiloton bomb sank several ships, but only battered the *Nevada* (Polmar and Norris 38). It is believed that the lack of accuracy was due to intense oscillations the bomb experienced after being dropped.
- On 25 July 1946, for test Baker, a Mk 3 bomb was detonated 90 feet below the landing ship LSM 60. This bomb also had a yield of approximately 21 kilotons, and caused a column of water nearly a half-mile across to rise 6,000 feet into the air. Many additional target ships were sunk or damaged (Polmar and Norris 38).
- A planned third test, named test Charlie, which called for an underwater detonation 1,000 feet below the surface, was called off (Polmar and Norris 38).
- These tests were the final weapons tests the Manhattan Project ever completed (Gosling 55).

Leon D. Smith Biography

- Leon D. Smith was born on June 24, 1920 in the township of Lindina, Wisconsin.
- He was drafted into the U.S. Army in January of 1943 and was selected to receive a commission after scoring extremely well on an aptitude test. Leon was sent to basic training at Fort Sill, Oklahoma as a Private in the Field Artillery.
- After his service in the Artillery, an experience that greatly affected his hearing, Leon attended Yale University in the Fall of 1943. Upon graduation Leon was commissioned as a Second Lieutenant.
- After he received his commission Leon was sent to Harvard University to study electronics. Upon completion of the electronics program at Harvard, Leon attended the Massachusetts Institute of Technology (MIT) to study RADAR.
- The Army then sent Leon to Boca Raton, Florida, for flight training.
- After successful completion of flight training he was sent to Wendover, Nevada in November, 1944. He was assigned to serve as a weaponeer in the 509th Composite Group, which was formed to carry out the atomic missions against Hiroshima and Nagasaki, Japan. Leon was the back-up weaponeer for the Hiroshima, mission, having lost a coin toss to Second Lieutenant Morris Jeppson.
- Leon left the U.S. Army in 1946, taking only thirty minutes to out-process.
- Leon joined Z-Division of the Los Alamos Group and was sent to the Bikini Atoll in support of "Operation CROSSROADS," the United States' first postwar nuclear test.
- Mr. Smith served as the weaponeer for the Operation CROSSROADS – ABLE test, and still owns the green plug used to make the weapon electronically safe.
- After CROSSROADS Leon specialized in the design of arming, fusing, and firing subsystems with Z-Division of the Los Alamos Group, later to become Sandia National Laboratories.
- Mr. Smith pioneered Sandia National Laboratories' initiative to develop environmental sensing devices and Permissive Action Link (PAL) components. These played an invaluable role in our nation's commitment to nuclear weapons safety and security.
- Leon extended his expertise to support intelligence gathering on nuclear matters and working in the Comprehensive Test Ban Treaty verification programs for over two decades prior to his retirement from Sandia National Laboratories in 1988.
- Leon and his wife Marie have three sons, Stephen, Bradly, and Phillip, and six grandchildren
- He helped develop the backpack bomb, described below

B-54 SADM "Special Atomic Demolition Munition"

- **Length:** Shipping container ≈ 35 in (Gibson 234)
- **Width:** Shipping container ≈ 26 in (234)
- **Height:** below 27 in (234)
- **Weight:** under 163 lbs (234)
- **Yield:** kiloton class (234)
- Only U.S. ADM that can be used offensively (234)
- Smallest device the U.S. has ever deployed (234)
- Can be transported by helicopter, truck, jeep, or backpack (234)
- "According to the October 1983 Montebello Decision, by 1985 all SADMs were to be removed from Europe. Dismantlement began soon after this, and by 1992 the SADM was no longer in the stockpile." (Gibson 234)

Source

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